

Book of Chapters:

Resilient Heritage & Adaptive Urbanism

Editors: Assoc. Prof. Dr. Rokhsaneh Rahbarianyazd
Assoc. Prof. Dr. Hourakhsh Ahmad Nia

2025



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Rokhsaneh Rahbarianyazd
Hourakhsh Ahmad Nia
Editors

 **Cinius Yayınları**

Cinius Yayınları Publication

Babıali Cad. Çatalçeşme Sok. No. 1 Cağaloğlu 34410 İstanbul, Turkey

www.ciniusyayinlari.com

Title of the book: Resilient Heritage & Adaptive Urbanism

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eISBN: 978-625-5866-76-9

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Preface

Resilient Heritage & Adaptive Urbanism

The accelerating pace of urban growth and the mounting pressures of climate change have propelled the safeguarding of cultural heritage and the evolution of urban form to the forefront of academic and professional discourse. *Resilient Heritage & Adaptive Urbanism* responds to this global challenge by bringing together fifteen rigorously reviewed chapters that examine heritage, vernacular knowledge, and urban adaptation through multidisciplinary lenses.

This edited volume is organised into two complementary parts. **Part I – Foundations of Vernacular Architecture and Community Resilience** foregrounds the intrinsic wisdom embedded in traditional built environments and the social mechanisms that sustain them. From Northern Mexico's adobe settlements (Chapter 1) to the reinterpretation of courtyard morphology in diverse climates (Chapter 2), the contributions distil lessons that guide contemporary design without erasing local identity. Subsequent case studies investigate the anthropological fabric of a virgin village on India's Banni grasslands (Chapter 3), measure residents' satisfaction within Algeria's informal housing (Chapter 4), and explore drone technologies for documenting Bahrain's endangered heritage (Chapter 5). Collectively, these chapters illuminate how vernacular principles, participatory governance, and emerging tools can reinforce the resilience of communities facing socio-economic and environmental stressors.

Part II – Heritage Conservation, Monitoring, and Adaptive Re-use advances the discussion from diagnosis to intervention. The section opens with an exploration of users' perceptions of 'traditional' places (Chapter 6) and proceeds to a detailed survey of Italy's historic transhumance landscapes (Chapter 7). The micro-scale reinterpretation of Howard's Garden City concept in Poznań (Chapter 8) and the revitalisation blueprint for Isfahan's Darb-e-Ghasr quarter (Chapter 9) each exemplify context-sensitive urban regeneration. Innovative monitoring techniques underpin Chapters 10 and 11, where predictive airborne routing and signal denoising models advance the stewardship of fragile heritage sites. The adaptive re-use of Bangladesh's folk music heritage (Chapter 12) and Iran's Parvin Etesami House (Chapter 13) demonstrate how cultural memory can be refreshed through creative programming. Closing the volume, Chapter 14 reassesses the urban role of Roman temples in Nicomedia, and Chapter 15 traces the influence of European Modernism on Mexican housing typologies—reminding us that mobility of ideas is itself a heritage process.

Across both parts, a common thread emerges: resilient urbanism requires an iterative dialogue between past and present, between the tangible fabric of cities and the intangible values of the societies that inhabit them. The case studies gathered here celebrate diversity of place while revealing convergent strategies—community participation, data-driven diagnostics, and adaptive frameworks—that can be replicated elsewhere. Practitioners will find methodological guidance for heritage audits, researchers will encounter fertile ground for comparative inquiry, and policy-makers will gain evidence to craft inclusive development agendas.

We are indebted to the chapter authors, whose scholarship and fieldwork enrich every page; to the anonymous peer reviewers, whose careful critiques ensured academic rigour; and to Alanya University for providing a collegial environment in which this collaboration could flourish. Special thanks are also extended to the production team and to our families for their unwavering support throughout the editorial process.

It is our hope that readers will engage critically with the insights offered, adapt them to their own contexts, and in doing so contribute to cities that honour the past while equipping themselves for an uncertain future.

Alanya, Turkey | May 2025

Assoc. Prof. Dr Rokhsaneh Rahbarianyazd

Assoc. Prof. Dr Hourakhsh Ahmad Nia

Editors

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PART I
Foundations of Vernacular Architecture and
Community Resilience

Chapter 1

Comparison of Characteristics of the Vernacular Architecture of Northern Mexico

* Sindy Melissa Godínez De León, Anna Gabriela Cruz Chaffardet, Andrea Sofía Gámez López

Introduction

This study compares vernacular architecture in northern México, focusing on the states of Nuevo Leon and Chihuahua. The research seeks to identify similarities and differences in both region's construction solutions, materials used, and climate adaptation strategies. The methodology applies the analysis of four representative case studies selected for their architectural value and relevance in preserving traditional techniques.

The work prioritizes the qualitative approach, combining fieldwork, historical documentation, and morphological analysis of the buildings. The evaluation criteria include the use of local materials, the response to the arid and extreme climate, and the evolution of living spaces based on the sociocultural needs of each region. The results will allow an understanding of how vernacular architecture has responded to northern México's geographical and environmental conditions, providing key information for its conservation and reinterpretation in the contemporary context. The study seeks to show regional architectural heritage and the generation of sustainable strategies in current architecture.

The vernacular architecture of northeastern México is characterized by a style heavily influenced by the colonial architecture inherited from Spanish colonization. These types of vernacular buildings have been transformed from residential to mixed-use, commercial, or even government buildings or museums. This research aims to study the most representative characteristics of iconic buildings in northeastern México to describe the representative elements that could be integrated into a possible planning process for the changing vertical housing landscape fostered by the densification of spaces in the residential area of Monterrey. Today, in the entire world, Mexican vernacular architecture is most closely associated with the architectural designs of Luis Barragán, Ricardo Legorreta, and Mauricio Rocha. These contemporary architects have based their design proposals on the vernacular elements of the architecture of the country's central region, where the use of color as a focal element, the use of central courtyards, the implementation of latticework, and the materiality of the site predominate. The three architects share a style characterized by the use of vibrant colors and lighting that combines modern and vernacular elements of the architecture of the country's south-central Mexican region.

This research seeks to study the most representative characteristics of iconic buildings in northeastern México to describe the representative elements that could be integrated into future planning. The team considered that the northeast of México comprises the states of Tamaulipas, Nuevo León, Coahuila, and Chihuahua. It is pertinent to mention that the colonization of México was primarily in the south-central area of the country, leaving the northeast in a late colonization, where desert climatic conditions predominate. An essential point in the typological analysis of vernacular housing in northeastern México is that contemporary changes in customs, lifestyles, and materials have directly impacted the size of living spaces, their location within the local context, and the optimization and standardization of material modulation.

The research was developed on the premise that Mexican vernacular architecture represents an essential component of the tangible and intangible heritage in the central region of the country but has been little explored in the north. The topic is of utmost importance, corresponding to bioclimatic topographical, historical, social, and material conditions. The team's motivation was lacking technical information and documentary historical material from graphic records. Comparative study seemed to be the way to go deeper into the topic. Surveys, photographic logs, and three-dimensional modeling were used to document and compare four buildings' spatial and constructive characteristics in Chihuahua and Nuevo León. The team chose them because their original purpose was residential, although most currently serve as museums. Another important criterion was the location of the buildings in the historic centers of each city. The research question was: What are the differences and similarities

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How to Cite This Chapter:

Godínez De León, S. M., Cruz Chaffardet, A. G., & Gámez López, A. S. (2025). Comparison of characteristics of the vernacular architecture of northern Mexico. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 1–10). Cinisius Yayınları. <https://doi.org/10.38027/N1ICCAUA2025EN0237>

in the spatial distribution, materials, and elements of four representative case studies of vernacular architecture from Chihuahua and Nuevo León, based on their analysis using architectural surveys and three-dimensional modeling? The research team addressed another question: How can some of these elements be recovered in contemporary architecture to reclaim the identity of northern Mexican architecture in single-family and multi-family housing design courses? The study's main objective is to compare four representative buildings of vernacular architecture in Chihuahua and Nuevo León by analyzing materials, functional elements, and spatial organization through surveying and three-dimensional modeling.

Research Gap in the Vernacular Architecture of Northern Mexico

According to Tamez (1992), vernacular architecture is related to a community's traditions, customs, and family life. These buildings adopt a practical and simple design without a focus on aesthetics. Their objective is to satisfy the fundamental needs of residents and utilize the sources available in the surrounding environment. Using local materials allows each building to be unique, tailored to its location, and responsive to its surroundings. Climate and the availability of certain materials define the structure and character of vernacular architecture, along with the customs and methods of local builders. Communities from the country's center and the Iberian Peninsula settled in northern México. Local architecture shows influence from both groups, with modifications adapted to a harsh climate. The community simplified its architecture due to environmental restrictions, the lack of interaction with local indigenous cultures, and the availability of materials.

According to Castillo (2023), vernacular architecture reflects the way of life of a group, where their culture, tradition and knowledge generate schemes that are transmitted over time. This demonstrates the importance of implementing techniques that have been passed down from generation to generation over the years, highlighting the significance of the relationship between empirical construction techniques and their connection to the environment. Tostado (2018) mentioned the recovery of the values of ancestral architecture will serve in the future to propose and construct spaces that are efficient in terms of spatiality and constructability. One of the objectives of the study is to make it know, to foster a sense of identity in the new generation of architects being trained at the University of Monterrey. Caruso (2020) mentions that people appear to have a major propensity to take care of ancient architecture when they have feelings of belonging to it. That's exactly what the school of architecture wants to promote in the students and staff.

Objectives and Hypotheses and Relevance of the Study

This research aims to analyze four architectural buildings considered vernacular by the National Institute of Anthropology and History in northeastern México and compare their functional and constructive characteristics. The specific objectives of this research include describing the most representative architectural elements of the buildings located in the historic centers of Monterrey and Chihuahua. The aim is to identify the aspects of vernacular architecture that remain contemporary in the 21st century. A third purpose is to compile information to be used as a study and application tool for the single-family housing workshop, focusing on passive sustainable strategies.

Identifying vernacular elements from northeastern México will allow the recovery of passive sustainable strategies in the projects of the simple-family housing workshop, reinforce the transversal knowledge of the courses on Mexican architecture and northeastern heritage, and identify them within the implementation of proposals.

The specific objectives of the research are:

- Conduct detailed architectural surveys of the four buildings
- Construct three-dimensional models that represent their original and current conditions
- Identify the materials and construction techniques used in the different buildings
- Analyze the functional architectural layout by comparing the uses assigned to the spaces in each example
- Create a comparative matrix demonstrating similarities and differences according to the established parameters.

Despite sharing an adaptative vernacular logic, traditional architecture in Chihuahua and Nuevo León exhibits significant differences in its materials and architectural and functional elements. These differences correspond to each context's climatic, cultural, and material conditions. However, similar patterns persist in the spatial organization of spaces, spatial use, and habitability.

As King (2001) quotes, referring to the author Jaime Rantel, "vernacular architecture is that which is born from the functional and formal needs of a region, both from the use of its natural resources and to build it" what is true is that vernacular architecture has as one of the main characteristics that it adapts to the location and the existing microclimate of the context. The study's relevance is that this type of analysis fosters a critical approach to contemporary design, promotes the rational use of materials, and strengthens the ability to design living spaces adapted to their context rather than imposing foreign solutions. In this sense, vernacular architecture becomes a valuable source of applicable learning, both in formal and functional terms, contributing to developing a more conscious, resilient, and relevant architecture for local realities.

The knowledge acquired from this study will be applied in the multi-family housing workshop. Lang (2005) refers to this type of housing as a building typology designed with multiple housing units integrated within a single

building or complex. This type of housing is primarily found in a vertical format, in the form of low- medium or high-density buildings. In the last 50 years, they have become a solution to rapid urban growth and the need to optimize the densification of cities. In the Mexican context, three cities have experienced rapid growth: México City, Monterrey, and Guadalajara.

Background and Context

According to King (2001), in México, the study of vernacular architecture in the south-central part of the country predominates, leaving the architecture of the northeast and northwest of the country little documentation and scarce recovery intervention for new uses. This lack of information became one of the limitations in the study prepared because most of the information and articles related to vernacular architecture are associated with the catalog of the National Institute of Anthropology and History (INAH)

Monterrey was founded in 1596 by Diego de Montemayor. It was established as "Ciudad Metropolitana de Nuestra Señora de Monterrey." The original layout of Nuevo León consisted of the Church of San Francisco, houses with predominantly stone and adobe construction materials, wooden roofs, and tile. These houses were characterized by being single-story houses with a central courtyard. On the other hand, the historic center of Chihuahua was founded one hundred and thirteen years after Monterrey. The registered founding date is the year 1709, by Antonio Deza Ulloa with the name: "Real de Minas de San Francisco de Cuéllar." It was a city founded as a mining settlement. The San Francisco de Asís temple, dated 1715, was constructed among the first buildings, according to the INAH. The College of Mother of Loreto (1718) and the Cathedral of Chihuahua were built in 1725 and completed one hundred years later. According to Azevedo (2016), This architecture is recognized for its outstanding heritage value, reflecting the culture and traditions of a specific region. However, it remains associated with the past, with underdevelopment and poverty. The fact is that vernacular architecture has much more potential than old techniques. Suppose new architects understand which elements can be incorporated into the current context. In that case, the territory can be transformed, meeting the needs of its users and keeping it in harmony with its surroundings.

Jimenez (2014) mentioned that the value of vernacular buildings and texts lies in the fact that they are documentary information, open books that tell us about the past and present. They tell a story about the evolution of a community. Thus, population and their surroundings, regardless of latitude, become precise settings of cultural landscapes where we can perceive and contrast the relationships between human beings and between them and their natural environment. Fernández (2021) complements by arguing that vernacular architecture is important manifestation of culture that materializes the way of understanding the environment and relating to it. The reflection that motivated the work team to develop the study was precisely the curiosity and the need to compare the elements present in the chosen case studies, but above all, which elements can contribute to be implemented in contemporary architecture to make it more efficient. It is important to highlight that vernacular architecture becomes not only a mirror of civilization, leaving a record of what the construction techniques of a time were, but also of what life was like back then. Ortiz (2011) said that as a rule, vernacular architecture reveals the characteristics of the human group more clearly than grand residences, which tend to manifest themselves in languages foreign to their reality, using fashions imposed by international architects. It is important to value local technical constructions knowledge that adapts to the bioclimatic conditions of the region, specifically in the case of Mexico, to the warm desert climate that predominates in the north of the country.

Materials and Methods and the cases study

The qualitative and comparative research utilized graphic documentation and digital modeling techniques. The four phases of the process were executed. The first phase includes the architectural survey, which provides for measurements, sketching, a site visit, and photographic records. The second phase was three-dimensional modeling, which used the measurements and information collected to document the information gathered. The third phase consisted of classifying the photographs and performing a comparative analysis. This analysis included material, construction techniques, use of the space, and function. The fourth phase consisted of preparing a summary table containing the information gathered.

The study of vernacular architecture in northeastern México holds historical and cultural value. It has profound practical utility in learning and developing projects within the single- and multi-family housing workshop. Therefore, the team analyzed four case studies to understand how local communities, over centuries, ingeniously and sustainably resolved housing needs in extreme climate contexts. Knowing vernacular architecture allows future architects to build a solid foundation for designing with sensitivity and responsibility. Before designing, it is essential to understand architecture not as an isolated product but as a comprehensive response to the environment, available resources, and social dynamics.

The case studies were chosen based on two criteria: the first criterion was their location within the city's historic center, as the most representative buildings are in the city's main squares. The second criterion was that the buildings had to be initially used for residential purposes. It's worth noting that the fact that the buildings were located on a corner, in the middle of the block, or occupied an entire block had no impact on the study. Currently, most of the buildings are segmented due to population growth in recent years, and most of them no longer serve residential purposes. Both have been converted into institutional buildings. After reviewing the urban layout's general characteristics, the evaluation case studies were selected. An essential factor in the selection was the availability of existing information on plans and the permits to conduct on-site measurements. Four case studies were investigated to compare the results of this research, two in Chihuahua and two in Nuevo León.

Chihuahua:

- Casa de Juárez, located at Avenue. Juárez 321, corner with Calle 5a, Col. Zone Centre, C.P. 31000, Chihuahua, Chihuahua. See figure 1.

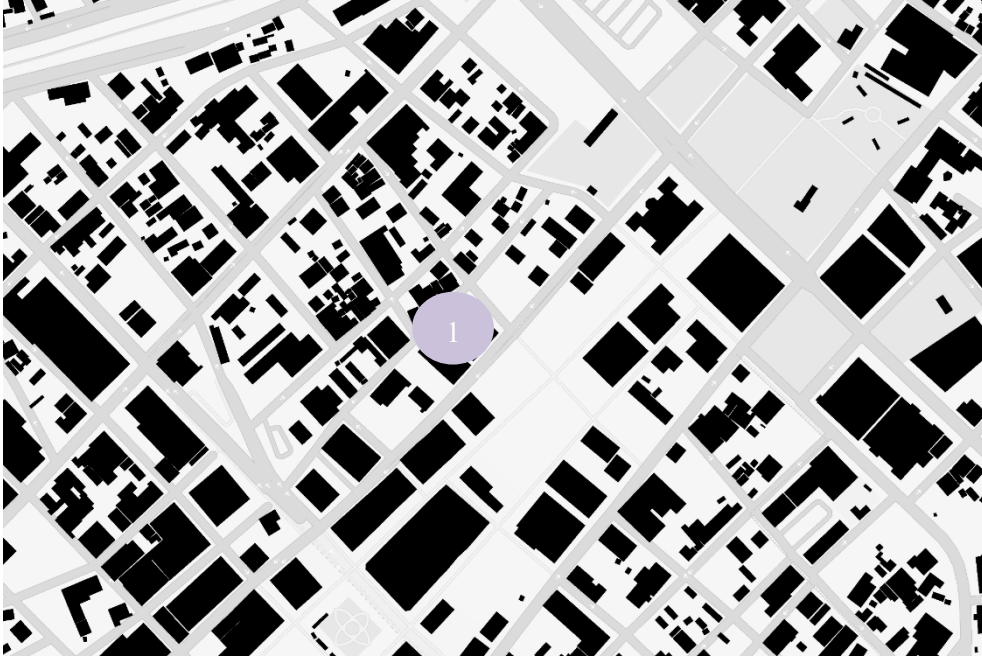


Figure 1. Localization of Cases Study. Casa Juárez in Chihuahua (Developed by Author)

- Museo Casa Camargo, located at Comonfort 104, Centre, CP 33700, Santa Rosalía de Camargo, Camargo, Chihuahua. See figure 2.



Figure 2. Localization of Cases Study. Casa Juárez in Chihuahua.

Nuevo León:

- 1. Museo Estatal de Culturas Populares, located at Mariano Abasolo 1024, Centre, Barrio Antiguo, CP 64000, Monterrey, Monterrey, Nuevo León
- 2. Hacienda Verona, located at Gral. Mariano Abasolo 871 y 881. Centre, Barrio Antiguo, CP 64000, Monterrey, Monterrey, Nuevo León. See figure 3.
-



Figure 3. Localization of Cases Study in Monterrey.

Chihuahua: La Casa Juárez

Located at Av. Benito Juárez 321, Zona Centro, 31000 Chihuahua, Chihuahua.

Its primary function was housing and serve as the office of the President of the Republic, Mr. Benito Juárez, during the period of the French intervention, from October 12th, 1864, to August 5th, 1865, from November 20th to December 9th of the same year, and from June 7th to December 10th, 1866.

During those years, the building also served as the seat of state powers until 1892, when the Government Palace was constructed. It remained unoccupied until it was designated as an educational building, creating Primary School No. 140, which served from 1894 to 1967. At that time, the governor, General Praxedes Giner, granted it to the Chihuahuan Society of Historical Studies under civic trusteeship. In 1967, the government granted the Society of Historical Studies property to become their offices. In 1972, on the centennial of the death of Benito Juárez, authorities opened the space as a museum and named it the Casa de Juárez Museum, and it was inaugurated in 2000. It is an adobe building with a floor plan like the traditional plans of colonial houses. Its main entrance is in the center of the house and has direct access to the interior courtyard, from which the house's different rooms are distributed. The rectangular courtyard features a roofed perimeter walkway delimited by lintelled arches, whose round-shafted columns with Ionic-style capitals are made of quarry stone.

Looking at the 3D rendering of the Casa de Juárez, notable elements can be identified, such as the door and window frames and ironwork protection on the façade openings. Ionic arches and columns surround the building's interior courtyard. It also features brick details interspersed at the corners of the façades, providing an aesthetic touch.



Figure 4. Collage of Casa Juárez (Collage Developed by Author)

Chihuahua: Casa Camargo

According to Presidencia Camargo (2009), the building was initially constructed as a residence and is now a cultural museum. It is located at the intersection of Trías and Comonfort streets in Chihuahua and represents typical 19th-century regional architecture.

The house includes several interconnected rooms that create a continuous circuit, enabling a professional experience. This layout allows for the appropriate design of spaces dedicated to the exhibition of significant works and objects. The central area is adapted for various cultural events, and a storage room serves as a general archive. The building houses several distinct areas:

- Historical exhibition rooms with photographs and objects
- A hall dedicated to notable local figures, which displays portraits, personal belongings, and samples of their work
- An art exhibition room for photographic, pictorial, or sculptural works of local and guest artists
- A local craft store
- A multipurpose space for workshops, exhibitions, conferences, and more.



Figure 5. Casa Camargo (Developed by Author).

Nuevo León: La Casa del Campesino

According to Cavazos, I. (2019), the building currently known as the Museo Estatal de Culturas Populares de Nuevo León, located in the Barrio Antiguo of Monterrey, México, has undergone a functional evolution over time. Its history dates back to the 18th century. Initially, the property was used for residential purposes, later serving hospital, educational, and social welfare functions, and was eventually adapted for cultural, recreational, and leisure uses as a museum.

At the beginning of the 18th century, the land where the building now stands belonged to miner Santiago Barrera, who sold it to Nicolás de Vandale. Vandale later transferred it to General Alonso García Coello, who built a stone house on what was then San Francisco Street, next to the river. García Coello died in 1728, and his testamentary executor, Mateo de Lafita, sold the house in 1746 to Governor Pedro de Barrio, who lived in it during his term and left it as a pending payment legacy to the San Francisco convent.

Later, in 1766, the property was transferred to Governor Ignacio Ussel y Guimbarda, who resided in Monterrey between 1764 and 1772. It is believed that he was the one who constructed the house in its current form between 1764 and 1769. Inventories conducted after his death describe an impressive building with 25 rooms built of lime and stone, roofs made with over 800 wooden planks, fine carpentry elements of pine and mesquite, and a perimeter wall with multicolored clay battlements. The building also includes three interior courtyards.

At the end of the 18th century, Bishop Andrés Ambrosio de Llanos y Valdés established the Hospital Real de Nuestra Señora del Rosario in the building, which operated until shortly after 1850. Later, in 1856, Bishop Francisco de P. Vereá established a girls' school there, operated by the Sisters of Charity until their expulsion in 1874. The school was later reopened as Colegio San José and then renamed Colegio Mexicano during the religious conflict under the direction of teacher Mercedes Flores.

In the 1920s, a new chapel was built on the property, decorated by artists such as Crescenciano Garza Rivera, whose works represent a pioneering stage of muralism in the region. Later, during the Cardenista era, the building was handed over to peasant organizations and became known as the Casa del Campesino.

The images show how the façade follows a rhythmic pattern in the placement of its windows and subtractions. Using baseboards on the façade, with a stone finish, is also evident. The thickness of the walls, the use of arches, and the lime and sand plaster finishes on the interior and exterior of the building are also noticeable. See figure 6.



Figure 6. Casa del Campesino / (Collage Developed by Author).

Nuevo León: Hacienda Verona

Hacienda Verona is at the corner of General Mariano Abasolo and Diego de Montemayor streets. According to the Government of Nuevo León (2013), this building was built in the 20th century. Its Art Deco style characterizes it; however, elements of vernacular architecture from Nuevo León can be identified in its morphology and materiality. Its original use was residential. It was later converted into a meditation school and functions as an event hall. At

present, the building is in good condition in terms of its façades, walls, and roof. The façade is finished with a lime-sand plaster over walls made of stone blocks. The ornamentation on its south and east façades, which face the street, shows a neocolonial influence in the Tuscan pilasters and the undulating molding that runs along them. Located on a corner, its façades feature main and service entrances. We can notice that the building has its Deco ornamentation, with vernacular and neoclassical influences, in elements such as the columns and pilasters, as well as the rhythm in the façade. It features a central courtyard surrounded by arches. Stone walls and wood ceilings are notable in his interior.



Figure 7. Hacienda Verona (Collage Developed by Author).

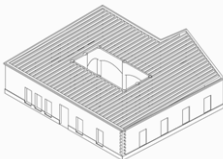
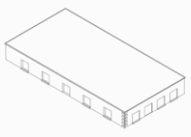
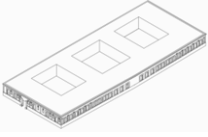
Results and Discussion

Despite their geographical differences, Monterrey, with its more humid climate and proximity to the Sierra Madre Oriental and Chihuahua in the heart of the northern desert, both cities developed architectural solutions that respond to extreme climatic conditions, such as the use of thermal materials (adobe, stone, lime) and natural ventilation systems. Likewise, the layout of the central courtyards, flat roofs, and thick walls are common elements that allow us to identify the regional architectural language. This presentation will compare these characteristics and the elements that can be preserved today.

Casa de Juárez is a clear example of how it's possible to maintain the essence of a building over the years. Its primary function was residential, but it is currently a museum, with its main elements intact, such as its central courtyard, arches, and the placement of its windows and doors. The main façade remains intact, with only changes in paint color over the years. Casa Camargo, as Casa de Juárez, has historical significance. Its primary function was residential, but it has changed over the years. It is currently a cultural museum. It has distinctive elements, such as the use of brick in the corners of its façades and as sun protection. Its interior has been completely modified in terms of materiality. In Nuevo León, both case studies are notable examples of the evolution of vernacular architecture. Despite stylistic differences, given that the second case study implements neocolonial elements, both buildings showcase key elements found in Nuevo León's vernacular architecture through their materials—ashlar stone in walls and oak wood on beams, the layout of the central courtyard, and construction techniques.

Elements to be used in contemporary residential architecture: Use of traditional materials such as adobe and ashlar stone; wooden ceilings and beams; ironwork on windows and doors; courtyards and arches, warm colour palettes; height (hot semi-arid climate); passive sustainable strategies and wall thickness.

Table 1. Comparative of typologies

	Casa de Juárez	Casa Camargo	Casa del Campesino	Hacienda Verona
Typology				
#Floors	1	1	1	1
Height	5m	4m	5.5m	5.5m
Original Colour	Red	White	White/ yellow/ red	White
Original function	Single-family house	Single-family house	Single-family house	Single-family house
Actual function	Museum	Museum	Museum	Events
#Pacios	1	0	3	1
Type of arches	Segmental arches	-	Three cantered arches	Three cantered arches
Type of column	Round/ionic	Squared / non-exposed	Round/ionic	Round / Tuscan
Foundation	-	-	Cyclopean foundation	-
Pavement finish	Rock, marble, and wood	Wood and marble	Polished concrete	Ceramic
walls	Adobe	Adobe	Ashlar	ashlar
wall thickness	0.5m	0.5m	1m	0.4m
Interior wall finish	Lime and sand mortar	Lime and sand mortar	Lime and sand mortar	Lime and sand mortar
Exterior wall finish	Lime and sand mortar	Lime and sand mortar	Lime and sand mortar	Lime and sand mortar
ceiling	wood	wood	wood	wood
Roofs	Concrete	Tile	Concrete	Tile
Doors	wood	wood	wood	wood and steel
window	wood and steel	wood and steel	wood and steel	wood and steel

Conclusion

In conclusion, similarities were observed between vernacular architecture in Chihuahua and Nuevo León, such as the presence of arches in the interior courtyards of the Casa de Juárez, the Casa Camargo, and the Casa del Campesino buildings. The ironwork detailing in the four vernacular dwellings is also present, merely protecting windows and doors. The vernacular architecture analyzed in this research focused on residential aspects, which is

interesting given how these buildings' simple, functional structure allows for variations in functional elements, as they currently serve entirely different functions, focusing on social and cultural aspects. It's worth noting that these vernacular aspects seem to be observed less in current architecture, leading to thermal discomfort. One key feature often missing is the central courtyard, which traditionally played a vital role in regulating indoor temperature. By promoting natural ventilation and creating shaded, cooler areas within the home, courtyards helped reduce the harsh climatic conditions typical in both regions. Knowing vernacular architecture allows future architects to build a solid foundation for designing with sensitivity and responsibility. Before designing, it is essential to understand architecture not as an isolated product but as a comprehensive response to the environment, available resources, and social dynamics. The final reflection remembers a phrase that Heyn-Jones (2022) said about vernacular architecture, the author situates the vernacular as 'remittance house' and discusses the materialities and temporalities of these operas calling them 'dream houses', it refers to the thermic efficiency and the original proportion of the constructions declaring that houses in themselves are a work of art to perform art.

Acknowledgement

Special thanks to the University of Monterrey Research Unit for their support in disseminating this documentation research.

Conflict of Interests

The Authors declare that there is no conflict of interest.

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Chapter 2

The Evolution of Courtyard Architecture

*Seyed Sepehr Ebneali

Introduction

This chapter examines how courtyard architecture across Persian, Ottoman, and Andalusian traditions embodies principles of resilient heritage and adaptive urbanism, forging sustainable microclimates and vibrant social spaces. Drawing on typological analysis and cultural studies, I explore iconic examples—such as the chahār-bāgh gardens of Isfahan, the sequential courts of Topkapı Palace, and the sensory-rich patios of the Alhambra—to illustrate how water, geometry, and enclosure shape human experience. By integrating nature, light, and social priorities, these courtyard systems anticipate contemporary imperatives for urban resilience. Adaptive heritage strategies, far from being static relics, offer dynamic models for innovative urban design.

I begin by situating courtyard architecture within the discourse of heritage resilience and urban adaptability, then synthesize key theoretical constructs that reveal how inner-court systems endure and adapt. Next, I conduct a comparative typological analysis—framed by black-and-white analytical diagrams—across the three traditions. Drawing sensory narratives of temperature, sound, and light, I demonstrate how these spatial matrices mediate climate and culture. Finally, I discuss implications for contemporary practice, proposing a framework for embedding courtyard principles into modern dense-city interventions, addressing the urgent need for climate-responsive, socially inclusive, and culturally grounded urban design.

Theoretical Framework: Resilient Heritage & Adaptive Urbanism

Resilient heritage refers to the capacity of historic architectural forms to absorb, adapt to, and recover from environmental, social, and political disturbances (Folke, 2006). Adaptive urbanism describes the iterative processes by which built environments evolve in response to changing needs and constraints (Conzen, 1960). Integrating these perspectives positions courtyard architecture as a living archive of ecological intelligence and social negotiation—a repository of spatial solutions that continually recalibrate to new pressures.

Courtyard geometries—whether the quadripartite chahār-bāgh, the cascading sequence of Ottoman courts, or the radial symmetry of Andalusian patios—enact legible spatial orders that reinforce collective memory and place identity (Vale, 2014). Such continuity ensures that successive generations inherit a coherent framework, facilitating reinterpretation rather than wholesale reconstruction.

Inner courts function as self-regulating microclimates. Evaporative cooling from fountains or shallow pools lowers ambient temperatures through latent heat transfer; high walls and vegetative shading reduce solar gain while channeling wind (Givoni, 1998). Light is diffused through latticework and reflective water surfaces, tempering glare and animating interiors with dynamic patterns.

Courtyards are semi-public commons where social norms, rituals, and resource management converge. Extended families in Persian homes collectively governed water distribution, upkeep of vegetation, and communal gatherings, embodying collective-action principles (Odendaal, 2011). Ottoman palace courts mediated protocol, privacy, and processional hierarchies, codifying social agency in spatial sequencing. Andalusian patios integrated artisanship and civic life, hosting festivals and markets under the shade of orange trees.

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How to Cite This Chapter:

Ebneali, S. S. (2025). The evolution of courtyard architecture. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 11–14). Cinius Yayınları. <https://doi.org/10.38027/N2ICCAUA2025EN0181>

Comparative Analysis

• Persian Courtyards

Persian courtyard architecture is distinguished by its strict symmetry, axial geometry, and emphasis on water. In the classic *chahār-bāgh* layout, the space is divided into four equal quadrants by two perpendicular water channels converging at a central pool (Ruggles, 2008). This design – evident in famous examples like the Fin Garden of Kashan and the Hasht Behesht pavilion in Isfahan – embodies the idea of paradise: a serene enclosed garden in miniature. Ruggles (2008) observes that the traditional Islamic garden is “divided into four equal parts surrounding a central design element”, and that “water provides a counterpoint to the portioned green sections.” In Persian courtyards, flowing water serves both a practical cooling function and a spiritual symbol of purity (Necipoğlu, 2015; Ruggles, 2008). Surfaces of water reflect light into the courtyard and moderate temperature, while fountains and qanat-fed pools underline cosmological imagery (Ruggles, 2008; 6 Necipoğlu, 2015).

Courtyard houses in Iran typically feature high opaque walls and limited exterior openings, directing views inward. As Michell (1995) describes, traditional Muslim houses are “organized around an inner courtyard” with “high windowless walls... interrupted only by a single low doorway”. This inward orientation reinforces privacy and frames the garden as an oasis hidden from public view. Hosseini et al., (2015) classify several Persian house typologies (centralized, corner, partially-enclosed) all of which place the courtyard at the spatial core of the dwelling. Interiors open onto the courtyard via colonnades or iwans (vaulted halls), creating a layered transition from entrance to innermost sanctum (Petersen, 1996). Decorative geometry – tile patterns, *muqarnas*, and chiseled wood – further reflect the garden’s order. In summary, Persian courtyards marry rigorous geometric planning with lush vegetation and water, expressing an idealized vision of nature (Necipoğlu, 2015; Ruggles, 2008).

• Ottoman Courtyards

Ottoman courtyard design shares the inward focus of the Persian model but diverges in its social and climatic strategies. In Ottoman cities such as Istanbul, domestic and palatial complexes often consist of multiple pavilions arranged around an open courtyard garden (Michell, 1995). For instance, the Topkapı Palace is not a single building but “a series of separate units, with different functions, strewn around a beautiful garden”. Courtyards thus act as organizing hubs connecting reception halls, living quarters, and service areas. Water features remain important – fountains and shallow pools provide evaporative cooling – but their layout is typically less formal than the four-part Persian scheme, reflecting Ottoman preference for graduated enclosures and merging indoor/outdoor thresholds. Social hierarchy and privacy are key in Ottoman courtyard planning. Residences often distinguish public-facing spaces (such as the *selâmlık*, a reception wing) from family quarters (*harem*) with a sequence of courtyards (Petersen, 1996). Each successive courtyard or iwan effectively filters and controls access. Ottoman architects also employed extended colonnaded porticos (e.g. the arcaded peristyles around Topkapı’s courtyards) to provide shade and transition from exterior to interior (Michell, 1995). In the end, Ottoman courts serve dual roles: as buffer zones regulating visibility and as microclimates. They address pragmatic concerns (privacy, social order, ventilation) while still utilizing natural elements. The emphasis on segmented, multi-courtyard layouts with covered galleries reflects the empire’s administrative complexity and the Anatolian climate (Sluglett, 2008; Petersen, 1996).

• Andalusian Courtyards

Andalusian (Moorish Spanish) courtyard architecture represents a unique synthesis of Islamic and classical Mediterranean influences. In regions such as Al-Andalus, Muslims adapted Roman villa and Visigothic courtyard precedents to Islamic cultural norms. The most celebrated examples are in the Alhambra of Granada: the Court of the Lions and Court of the Myrtles. Michell (1995) describes the Alhambra as “a maze of rooms and courtyards... of water basins and canals that link the open and covered spaces”, highlighting its complex interweaving of gardens and architecture. Andalusian courtyards retain the formal symmetry of Persian antecedents but often incorporate long axial pools and reflective basins to maximize evaporation in the hot Iberian summer (Ruggles, 2008).

Gardens in Andalusia are typically inward-facing green courts with fruit trees, myrtle hedges, and rills (narrow water channels). Conan’s study of Andalusian gardens (2007) emphasizes their role in controlling temperature and privacy: tall walls shield courtyards from harsh sun and prying eyes, while fountains aerate the air. The spatial logic is evident in traditional Andalusian houses (*riads*), where an entrance leads directly into a courtyard rather than street-facing rooms (Petersen, 1996). The layout often features a central rectangular pool or multiple small basins along the axes. Decorative tiles and carved stucco ornamentation, as in Granada’s *efrènes* and *azulejos*, merge with the landscape to create a sensorially rich environment. To sum up, Andalusian courts balance functionality with aesthetics: they solve environmental challenges (cooling, light management) while manifesting ideals of order and harmony (Ruggles, 2008; Conan, 2007).

Findings and Discussion

The comparative study reveals that Persian, Ottoman, and Andalusian courtyards, while culturally distinct, converge on a shared design vocabulary centered on water, light, and geometry. All three traditions create inward-looking sanctuaries where nature and architecture interlock: water channels and gardens mediate heat and light, while symmetrical layouts imply cosmic order (Ruggles, 2008; Necipoğlu, 2015). For example, Persian *chahār-bāgh* gardens and Andalusian *riads* both use cruciform water patterns to symbolize paradise. Ottoman designs, though more pragmatic, still prioritize courtyards as framed landscapes that organize building complexes (Michell, 1995). This unity aligns with Rabbat's assertion that the courtyard house retains "universal relevance" beyond any single culture (Rabbat, 2010). In each case, the courtyard serves as a microcosm of order in an otherwise dense urban environment.

Our findings reinforce and extend prior scholarship. Ruggles (2008) argued that Islamic gardens are "earthly reflections" of paradise, and our analysis confirms this metaphor across Persian, Ottoman, and Andalusian contexts. We also corroborate Michell's (1995) characterization of the Alhambra's labyrinthine courtyards. In the Persian context, Hosseini et al.'s (2015) typological classifications are borne out by numerous case studies: central, axial courtyards are repeatedly identified as organizing principles. Ottoman sources (e.g. Petersen, 1996) emphasize privacy and hierarchy, which we observed in courtyard sequences. The interdisciplinary approach – combining architectural history and environmental studies – aligns with methods used by Petruccioli & Pirani, 2013 and Jani et al. (2015) in examining Islamic design principles.

This study's strength lies in synthesizing disparate traditions under common analytical categories. By coding design elements (water, geometry, enclosure) across regions, we elucidate a shared symbolic lexicon that transcends geography (Necipoğlu, 2015; Ruggles, 2008). It also highlights differences: for instance, Persian and Andalusian designs prioritize static symmetry and garden ornament, while Ottoman layouts emphasize modular units and human traffic. These differences reflect distinct social contexts – theocratic courts in Persia, bureaucratic palaces in Turkey, and frontier cities in Spain (Sluglett, 2008; Michell, 1995). The comparative framework thus deepens understanding beyond isolated studies.

Limitations of this research include its reliance on existing literature and interpretations. Vernacular variations and undocumented modifications – such as local adaptations of courtyard houses in rural Iran or Anatolia – may not be fully captured (Hosseini et al., 2015). Also, the symbolic interpretations (of water or geometry) are drawn from theoretical sources; archaeological or ethnographic validation would strengthen these claims. Future work could apply digital modeling (e.g. GIS or 3D simulation) to empirically test how these designs perform in climate control, as suggested by contemporary researchers (Petruccioli & Pirani, 2013; Jani et al., 2015). Likewise, comparative field studies of surviving courtyard houses could reveal how living traditions have evolved since the historical periods considered.

Conclusion

This study demonstrates that Persian, Ottoman, and Andalusian courtyard architectures, while regionally unique, share enduring principles that integrate symbolism and function. All three traditions valorize water, light, and geometric order: Persian *chahār-bāgh* gardens evoke paradise through formal axial layouts and fountains; Ottoman courts organize social space through layered enclosures that address privacy and climate; Andalusian courts synthesize these approaches into harmonious patios framed by Islamic artistry (Michell, 1995; Ruggles, 2008). Each tradition thus offers a distinct solution to similar challenges. As Rabbat (2010) and Ruggles (2008) suggest, the courtyard house persists as a universal archetype, adaptable across cultures.

Practically, these findings illuminate how historic courtyards meet modern needs. The same passive design elements – inward-facing green spaces, evaporative cooling, shaded galleries – can inform sustainable architecture today (Petruccioli & Pirani, 2013; Jani et al., 2015). By learning from Persian and Andalusian emphasis on garden geometry and from Ottoman spatial sequencing, contemporary planners can create dense yet humane urban environments. In conclusion, the evolution of courtyard design in Islamic architecture reflects an ongoing dialogue between nature, culture, and the built form. This dialogue endures, offering a template for architecture that is both aesthetically rich and ecologically responsive (Ruggles, 2008; Necipoğlu, 2015).

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 3

Anthropology of a Virgin Village Kutch's *Banni* Grasslands: Zararhwadi

* Tithi Soladhara, Nishant Kansagra, Prachi Patel

Introduction

The Banni grassland, located in the Bhuj taluka of Kachchh district, Gujarat, covers about 2600 km², making it the most extensive natural tropical grassland in the Indian subcontinent. It includes two ecosystems – wetlands and grasslands – and falls under the *Dichanthium-Cenchrus-Lasiurus* grass cover category (Manjunatha B L, April 2019). The area has 48 hamlets/villages organized into 19 Panchayats. In addition to permanent settlements, the *Maldhari* community sets up temporary settlements based on resource availability, such as water and grazing areas (*Gauchars*), which vary according to the season. Tourism and development of the Kutch-Bhuj region resulted in job creation, infrastructure development, an increase in the standard of living, an increase in resources, an increase in income of local people, and an increase in the need to settle in a geographical location, creating a nascent settlement (Khanna, February 2018). The opportunity for alternative livelihood with induced tourism has changed the patterns of non-stationary inhabitants (*Maldharies*). This results in a virgin settlement in the Banni region, making a community stationery. Infrastructure development, including physical accessibility, utilities like water and energy, local markets, and governance, often precedes the establishment of settlements. This holds for *Zararwadi*, a newly formed settlement inhabited by the *Maldharies* of Kutch, situated near *Hodko* village at the geographic center of the district. The town is characterized by its mud houses, desert landscape, and focus on experiential tourism. Villages such as *Zararwadi* are cataloged alongside *Hodko* as settlements populated by migratory communities (Dixit A., 2010). The settlements have mud houses called *Bhungas*, which are circular or polygon in shape, with thatched roofs, and are recognized for their earthquake resistance and climate adaptability. They also protect against sandstorms and cyclonic winds. As such, houses require regular seasonal maintenance and retrofitting to address wear and tear caused by natural elements and human activities (Priyanka Dey, 2024). The homes are clustered in peculiar patterns governed by socio-cultural reasons, livelihood, terrain, and natural resources.

***Maldharies* – the nomadic community that resides in the *Banni* grassland of Kutch**

For the first-generation residents, the dominant profession is animal husbandry, and the second generation is predominantly engaged in the hospitality industry, which results from the booming tourism industry (Himali Gor, 2024). The Kutch district's semi-arid *Banni* Grassland is renowned for its distinctive grasses and ecology. One of India's most significant grassland ecosystems, the terrain is ideal for grazing animals, which is crucial to the *Maldhari* community's way of life. The *Maldharies* are primarily known as herders. Their lives revolve around their livestock. The livestock provide them with milk, meat, and wool and serve as a source of income through trading animals and animal products. Their pastoral lifestyle has been intertwined with the region's ecological balance for centuries. The community has adapted to the harsh desert climate of Kutch, building their homes from locally available materials such as mud, thatch, and wood. These traditional houses, known as "*Bhungas*," are circular, with a conical roof, designed to withstand strong winds and hot temperatures. *Maldharies* have rich crafts, like weaving and embroidery, that are well known. The *Maldhari* community has been integral to preserving the *Banni* Grassland's delicate

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How to Cite This Chapter:

Soladhara, T., Kansagra, N., & Patel, P. (2025). Anthropology of a virgin village Kutch's *Banni* grasslands: Zararhwadi. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 15–22). Cinius Yayınları.
<https://doi.org/10.38027/N3ICCAUA2025EN0319>

ecosystem—their livestock's grazing habits help maintain the grasslands' biodiversity. Overgrazing has become a concern in recent years due to population pressures.

Decoding *Bhungas*

The settlement is organized as a cluster, with the houses arranged in three loosely defined strips aligned in an east-west direction as seen in Figure 2. The natural boundary of the trees protects the settlements from desert winds, especially dehydrating hot, dry, and gusty summer winds in peak summer and cold winds in winter. The vegetation is also the source of fuel for locals and fodder for cattle.

The units of *Bhunga*, on the periphery, are arranged so that the entrance faces towards the cluster's centre. The *Bhungas*, in the cluster's centre, are placed facing each other. This formation creates an introverted space within. Also, it encourages more interaction due to a visual connection. It was observed that people of all age groups use this interactive in-between space during different times of the day. An ample gathering space has formed in front of the *mukhiya's* (the town leader's) unit. The openness allows all the village members to gather and address the talk or celebrate festivals, feed the cattle, have children play, etc. The space becomes a community space for many activities. Also, the same space has different activities during varied times of the day and performs in various manners with the play of light and shadow. The settlement of *Zararwadi* shows a unique characteristic where the activity of the day is distributed across the settlement irrespective of the house ownership.

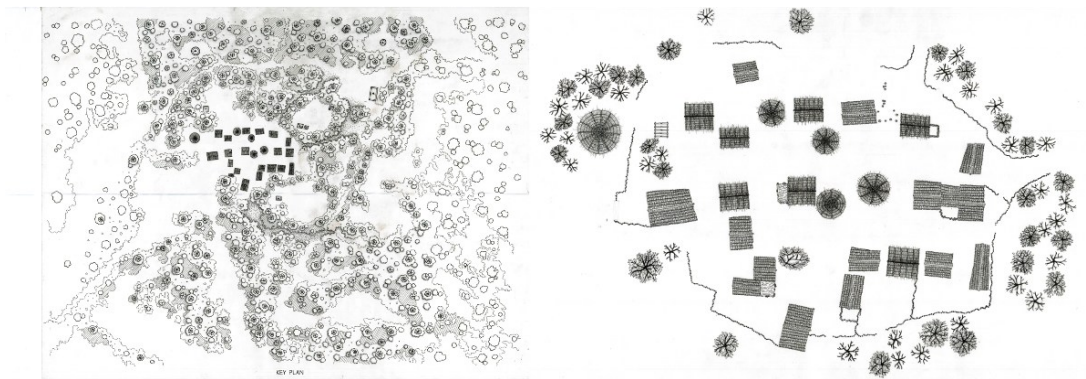


Figure 1. Bird's eye view of *Zararwadi* in *Hodko*, Kutch (Key plan, Floor plan).

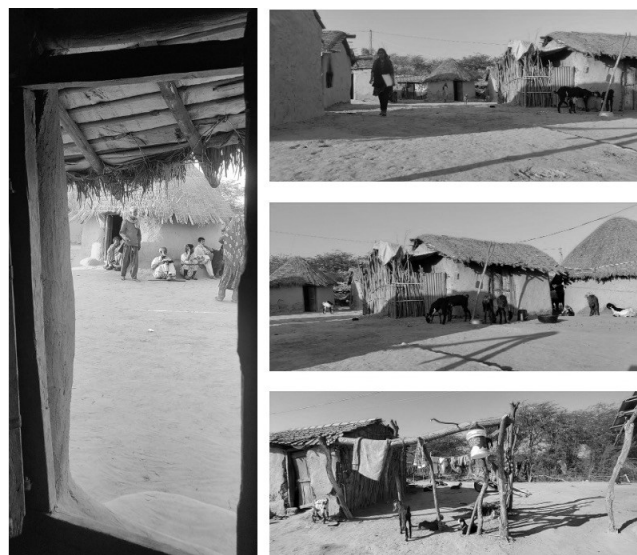
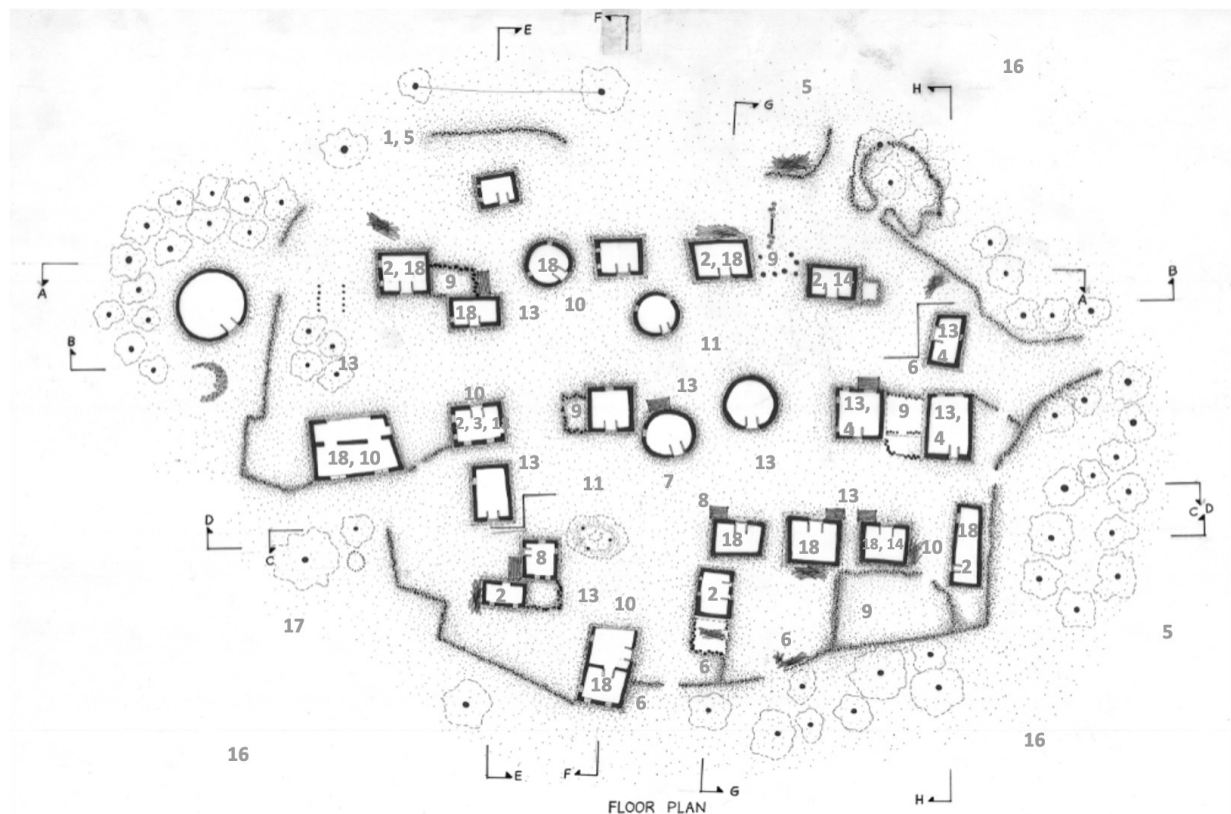


Figure 2. Habitat of *Zararwadi* in *Hodko*, Kutch (photo credits to the Authors).

Since the early twentieth century, traditional buildings have been examined by folklorists and within disciplines like ethnography, cultural geography, and material culture. These fields have approached such architecture as a tangible expression of human culture (Robert Brown, 2012). Cultural customs and communal rituals play a significant role in shaping and transforming these built environments, highlighting the significance of cultural influence in their development (Figure 3 (A)).



No.	Name of the Activity	Group / Individual	Gender (M/F/C)	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	Activity description
1	Bathing	I	M/F/C				*													-
2	Cooking	I/G	F																	-
3	Meals	G	M/F/C																	-
4	Craft activity	G	F					*	*	*	*									Done mainly by females for the running economy (Sewing machine is also used for the same)
5	Fetching water	I	F			*														Young girls from the village usually perform this activity
6	Laundry / washing utensils	I/G	F						*	*										Washing of clothes happen once in two days according to the amount of used clothes
7	Smoking & tobacco	I	M/F					*	*			*	*	*	*					Prefer beedi and tobacco
8	Getting firewood	I	M					*	*											Rs-50/ 40 kg, 2-3 people, also a source of earning(Rs. 250/day)
9	Milking cattle	I	M/F/C			*										*				Mostly by females
10	Evening tea	I/G	M/F/C												*					-
11	Sun bathing	G/I	M/F			*	*													Bath is usually done by females and elderly men
12	Playing	G	C						*	*	*		*	*						With individuals as well as cattle
13	Socializing	G	C/F				*									*				-
14	Nursing children	I	F			*														-
16	Grazing cattle	G	C/M				*	*	*	*	*									The children or males who take the cattle to graze are back before 1 pm (winter time)
17	Praying (azan/namaz)	I/G	M/F/C	*								*								Men usually go to masjid to pray while the ladies sit at homes and pray
18	Sleeping	I	M/F/C															*		-

Figure 3 (A). Activity Map of Zararwadi, Kutch (Above), Table captures the occurrence of activity across the day (yellow, orange, and blue as morning, afternoon and evening hours) (credits to the Authors)

The cultural influence on a building encompasses the full spectrum of human values, livelihoods, and material expressions that shape its design and use. Rather than viewing vernacular architecture—crafted from stone, timber, mud, or tin—as merely functional structures, it is more accurate to see them as reflections of intricate social and cultural dynamics. These buildings embody their inhabitants lived experiences, traditions, and community practices (Robert Brown, 2012).

It is distinctively observed that buildings (Here *Bhungas*) that store valuables, jewellery, clothes, and products, centered on economic activity like handicraft items, are located in the centre of the settlements and the entry doors face inward and also open inward, keeping them safe from anthropogenic factors governed by the eyes in the streets concept (Figure 3(B)). Moreover, these houses are constructed on raised platforms, ensuring safety

from natural events like rain, storms, and cattle roaming in the settlements (Figure 4, Section GG). The families that practice animal husbandry have cattle sheds near the living spaces with shared windows that ensure regulated temperatures in extreme winters (Figures 2 & 5 photographs).

There is a dominant practice of the community kitchen where families collectively own a shared cooking space (Figure 6 photographs) with nearby storage spaces that align with kitchen needs. The inhabitants of *Zararwadi* practice settlement-level Endogamy; hence, the settlement evolves into clusters of houses owned by families (Figure 3 (C)). It was interesting to observe that communal harmony practices include community cooking, a common space for storage (Figure 3 (B)).

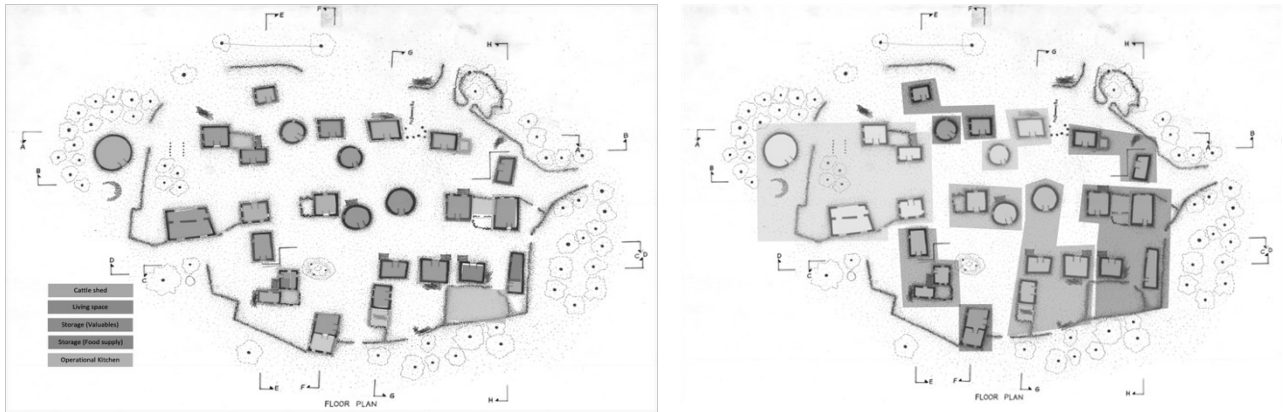


Figure 3 (B). Habitat of *Zararwadi*, Kutch, consolidated plan with function of the place (left) (credits to the Authors)

Figure 3 (C). Family clusters of *Zararwadi* (right) (credits to the Authors)



Figure 4. Plan and Section of *Zararwadi* in *Hodko*, Kutch (created by the Authors)

Built forms are subject to change with ongoing evolution in cultural practices and the socio-economic fabric of the inhabitants. Earth construction, especially vernacular buildings, has the opportunity to respond to people, place, and tectonics to sustain itself; however, it also follows the classic elements of architecture structurally to make it anthropomorphically habitable (Heath, 2019). Typically, *Bhungas* are mud houses constructed with dominant materials like cattle dung, soil, and water as required, with humidity for solidification. As per Figure 5, a typical wall section has a skeleton of locally available wood from babul shrubs that weaves horizontal and vertical sticks in the centre of a thick mud wall. The mud construction is not only cost-effective as the raw material is

abundantly available, but simple assembly processes are used in construction, making the house thermally comfortable indoors.

The walls can be constructed using cob construction, which involves mixing straw and small gravel into sandy soil. The resulting mixture is kneaded by hand, foot, or tools and then formed into lumps. These lumps are stacked vertically, with drying intervals between each layer. Once the vertical walls are formed, they are plastered to complete the construction.

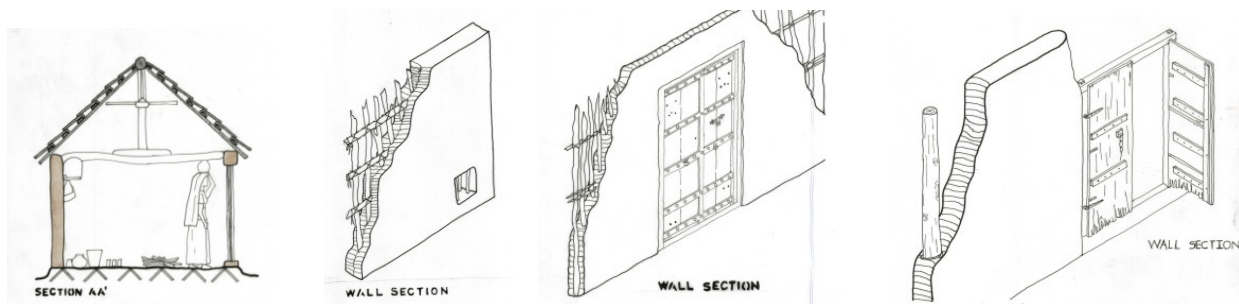


Figure 5. Wall section of houses in Zararwadi in Hodko, Kutch (created by the Author)

The floor of the *Bhunga* is constructed using the same materials as the walls: silt, cattle dung, and water, layered one over the other. This traditional technique is known as *Lippan*, where a fine paste of clay, finer than that used in the walls, is applied. The process involves a semicircular motion of the hands to apply the plaster, which is repeated twice to three times a year, depending on wear and tear. This repeated plaster application helps insulate the house and disinfect the surfaces following the monsoon season. Additionally, the re-plastering process incrementally elevates the structure by a few centimetres with each cycle, protecting from the dusty winds prevalent in the settlement.

The tapered thatched roofs are constructed using straw sourced from local grassland vegetation, while the beams supporting the roof are made from thicker logs of the Babul tree. Depending on the shape of the house, the roofs are typically either circular or rectangular with a tapered top, which may or may not include waterproofing. These roofs serve multiple functions beyond protecting the interior from external climatic conditions. The beams that hold the roof's straw also double as storage elements within the house. Items vulnerable to domesticated cattle or those requiring long-term storage, such as food or milk containers, are hung from the roof beams. This storage is anthropogenically accessible and includes provisions for air-drying food, lights, lanterns, and fans. The outer edge of the roof, where it intersects with the wall, features protruding logs that form a functional overhang, providing additional protection and utility.

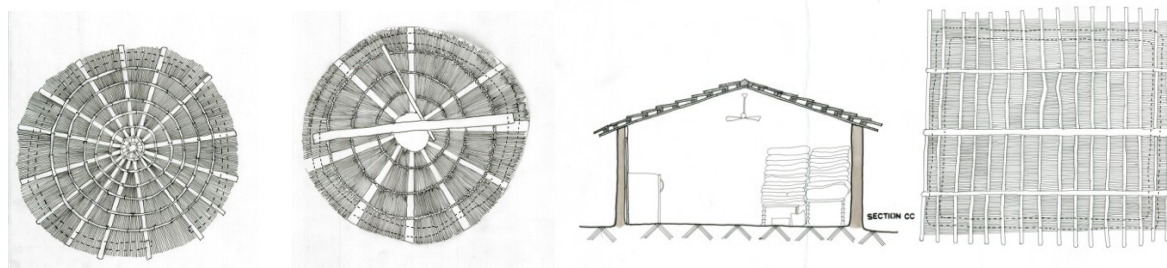


Figure 5. Roof details of houses in Zararwadi in Hodko, Kutch, Round roof (left) and polygon roof (right) (created by the Author)

Use of the Elements Anthropomorphically

Vernacular buildings evolve and have been sustained for generations, designed to meet the needs of growing families and changing needs (Robert Brown, 2012). Conventional buildings are a rich cultural resource with the potential for equivalent complexity, as they express multiple meanings. These buildings have characteristics expressed through form and decoration, as well as enclosed liveable spaces influenced by human rituals and daily life activities (Koebel, 1998). Village pathways and open spaces are paved with mud flooring (*Lippan*), this flattened land also acts as a spillover space for the community and often restricts the dust from rising

with wind, keeping the place habitable. The texture of *Lippan* is similar indoors as well as outdoors, maintaining the feel of the settlement as a home and the individual *Bhungas* as a subset of living spaces within the habitat.

The **entrance** of the *Bhunga* is slightly higher than the ground outside. This threshold serves as a transitional space between the inside and outside, where people can sit and work under natural sunlight. This space becomes essential as the houses cluster together, facing each other. This cluster again creates a sense of enclosure at the macro level in the settlement.

The columns: The two main wooden logs (in rectilinear form) act as the structure's main support and hooks for placing daily items.

The beams use small wooden logs or a large bamboo that acts as beams that hold the roof's straw and double as storage elements within the house. Items vulnerable to domesticated cattle or those requiring long-term storage, such as food or milk containers, are hung from the roof beams, shown in Figure 8. This storage is anthropologically accessible and includes provisions for air-drying food, as well as lighting, lanterns, and fans. The outer edge of the roof, where it intersects with the wall, features protruding logs that form a functional overhang, providing additional protection and utility.

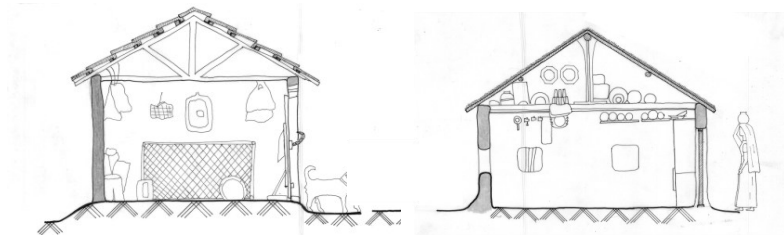


Figure 6. Wall section of houses in Zararwadi in Hodko, Kutch (created by the Author)

The floor: It is a straightforward and convenient way to carve out a floor and create a depression to place wood on fire to prepare their food. Along with a depression, they made a ring on the top to hold the vessels that act as *chula* (a stove made with mud) to make the food. Refer to Fig. 6. Dry wood is available in the region and used as a daily fuel for cooking. The roof tile above the *chula* is removed to allow smoke to escape from the unit. This arrangement acts as a chimney.

Additionally, some units are extended families, and they utilize a shared space for cooking as a communal area. The granary is just next to the cooking space. These units are mostly rectangular, with pitched roofs covered with Mangalore tiles. Additionally, these *bhungas* are located on the outer edge, where one creates a plinth that bulges out from the flat surface of the wall, serving as a sitting platform (*pali*). As these *bhungas* also formed a cluster of built structures, the sitting space serves as an interactive space for the neighbours.

Wash areas and common bathing spaces: Washing and bathing occur in the same space. Additionally, these villages lack plumbing facilities, making water availability a significant issue. Here, the washing space near the cooking area becomes a space for bathing. As the cooking space is only accessible to females, approaching the area becomes an unspoken norm. A bamboo fence surrounds the space and opens from above. Stone bases give a surface to bathe and water to percolate nearby soil. The kitchens, primarily accessed by women, are designed with adjacent spillover areas used for bathing and utensil washing. A simple arrangement — placing a stone slab on the ground and enclosing the area with a dense fence — allows used water to be naturally absorbed back into the ground, reflecting resourcefulness and ecological sensitivity.

Shades for cattle: These spaces are structured along with the structure of their respective units. They are just a skeleton of wood structures, like a primitive hut, partially covered by thatch. They are mainly used to keep cattle safe and bound inside the space. Also, firewood can be stored for domestic purposes. They are taken out to feed in the common area during morning and evening hours. These structures are mainly below or around the trees to utilize their mutual shading. The cattle sheds are lower in height than the surrounding house to protect the cattle from harsh, stormy winds of the desert and to share the thermal comfort of warmth in winter and mutual shading

in the summer months. The sheds are built with wood, allowing for breathability for cattle and easy replacement of material for the future.

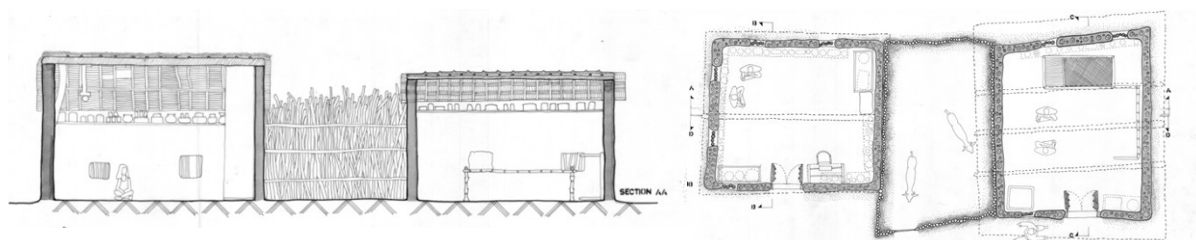


Figure 8. Cattle shade between two houses, Section (left) and Plan (right) (created by the Author)

Discussion and Conclusion

Context always plays a crucial role in shaping people's behaviour and built environments. In the case of *Zararwadi*, the habitat has evolved organically in response to socio-cultural practices. The village developed primarily in response to the availability of natural resources, particularly water and grass. The settlement's location is also relevant and complementary to the livelihood opportunity. The *Maldharies*—pastoral communities of Kutch—traditionally led a semi-nomadic lifestyle. However, with the increasing availability of resources and livelihood opportunities, they have begun settling more permanently as quasi-legal settlements. The settlement's growth is closely linked to the accessibility and consistency of resource availability, sustainability from a livelihood perspective, and access to markets and utilities, such as schools and hospitals. The increase in tourism and the community has also witnessed a rise in livelihood opportunities beyond pastoralism and craftsmanship, which is passed down informally and dominantly practiced by women. However, the cattle are in the epicentre of the daily life of these communities and their livelihood.

The typical situation where '*form follows function*' has been documented, as has the way the houses are constructed, and places are inhabited in these settlements. The elements of building materials offer abundance in terms of availability and thermal comfort. From the formation of clusters to the architectural aspects of the *bhunga*, every level of spatial organization reflects a lifestyle deeply intertwined with a profound cultural understanding. Natural boundaries made of *Prosopis juliflora* (Indian babul) protect the people and their domesticated animals from predators and the stormy winds of the desert. Village clusters have evolved incrementally through the accumulation of knowledge that responds sensitively to climate and socio-cultural needs.

- The orientation of *bhungas* typically faces inward, creating an introverted boundary and promoting community interaction.
- The spatial scale is well understood; the spaces between two or three *bhungas* create usable outdoor areas that foster visual and social connectivity, along with the *eyes on the streets* for young animals, children, and women, keeping safety in the epicenter.
- Clusters are organized so that shared facilities, like a communal storage area for valuables, are centrally located within the village.

Cattle are an integral part of the *Maldharies*; their shelters follow the *bhungas*, allowing residents to care for them closely, especially for young calves, lambs, and kids. Animals are integrated into domestic life, as seen in practical adaptations such as suspending clean utensils and food items on beams to restrict access and raising the entryway to the house, creating a physical barrier for animals to enter. However, there is synergy in the settlement as a shared living space for humans and cattle, with cattle sheds located between or near houses to facilitate thermal comfort exchange. Every structural element is thoughtfully used.

In essence, the settlement patterns and architectural choices of the *Maldhari* community are not just pragmatic responses to environmental and economic factors but are deeply rooted in cultural knowledge and collective memory. The seamless integration of livelihood, ecology, and social practices demonstrates a sustainable and adaptive way of living that prioritizes human and animal well-being. *Zararwadi* is a testament to how traditional wisdom can shape resilient and meaningful habitats when aligned with natural rhythms and communal values. Preserving and learning from such models is crucial, especially as we search for context-sensitive and inclusive approaches to contemporary rural and urban development.

Acknowledgement

This research was part of a series of learning workshops conducted as a part of the curriculum at the Institute of Architecture and Planning, Nirma University, at a settlement, *Zararwadi*, in Hodko Village of Kutch. The Authors have been instructors for the workshop aimed at exploring the vernacular habits of Kutch's Banni grassland. The drawings in the paper are original and were drafted as part of the research activity. A special thanks to the people of *Zarahwadi* for letting us into their village to conduct the research. This research did not receive any specific grant from public, commercial, or not-for-profit funding agencies; it was done for academic purposes.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 4

Urban Resilience through Participatory Governance and Resident Satisfaction in Informal Housing, Batna, Algeria

* Hana Medaregnarou Boubir

Introduction

The phenomenon of informal neighborhood in Algeria highlights profound structural shortcomings in urban governance. As Belguidoum and Mouaziz-Bouchentouf (2010) describe this situation as a paradox of urban policies, where the State fails to regulate urbanization, thereby allowing contested urban spaces to emerge. In most Algerian cities, this issue manifests clearly, as tensions surface between public policies and residents' practices. Residents construct outside legal frameworks and implement autonomous adaptation strategies in response to inadequate basic services, land insecurity, and environmental risks). Through their territorial rootedness, daily practices, and negotiation of space in urban peripheries, they actively display a form of bottom-up urban resilience.

Over the last few decades, the Algerian authorities have implemented two main approaches to solving the problem of informal housing: demolition and regularization. With law no. 08-15 of 2008 on urban planning and development (Ministry of Housing and Urban Development, 2008), the government established a legal framework for integrating these neighborhoods into the formal city. The authorities have made this integration conditional on physical improvements and demanded the active participation of residents.

These efforts can only be successful if residents are actively involved at every stage of the project. Participatory governance is based on the co-production of decisions between institutions and citizens, and is a key mechanism for transforming informal settlements. The habitats also take responsibility for working with local authorities to legalize their homes and gain public support for renovations (Zitoune, Zouaoui & Chabou, 2020). Through these actions, they help shape their future and play an active role in the transformation of their neighborhood.

In Batna, local authorities launched several urban improvement projects during the 2010-2014 five-year plan to improve the city's image and living conditions. One of the main projects was to develop the belt along the Oued Batna canal, which runs through the city center. However, economic and political crises delayed completion until 2019. In addition, residents resisted the demolitions, which disrupted the initial phases of the project. Although the authorities demolished some structures, they preserved most of the illegal buildings after consulting stakeholders. They imposed one condition: residents had to improve the facades of their houses after regularization (DPAT, 2019). All these forms of local adaptation demonstrate how residents gradually appropriate space and integrate it into the city's urban dynamics, revealing their urban resilience.

These developments raise a central question: How does participatory regularization influence residents' resilience strategies, the effectiveness of local governance and residential satisfaction in an informal settlement like Z'mala? The chapter addresses at how regularization policies can improve living conditions while respecting local social dynamics. The case of Z'mala allows us to observe how theoretical concepts - resilience, participatory governance and residential satisfaction - materialize in an ongoing negotiation between residents and authorities.

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How to Cite This Chapter:

Medaregnarou Boubir, H. (2025). Urban resilience through participatory governance and resident satisfaction in informal housing, Batna, Algeria. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 23–36). Cinius Yayınları. <https://doi.org/10.38027/N4ICCAUA2025EN0321>

Between 2019 and 2024, we conducted a retrospective study to assess how residents engaged with the transformation process and how they perceived urban change. The aim of this research was to identify concrete forms of participation by residents in the transformation of their neighborhood and to assess their post-intervention satisfaction with quality of life and the availability of services. This dual approach allows us to understand how participatory governance influences residents' behaviors and their perceptions of urban transformation, thereby reflecting local urban resilience.

This empirical chapter is divided into four sections. The first section establishes the theoretical framework, mobilizing the concepts of informal housing, urban resilience, participatory governance and residential satisfaction, while exploring their interconnections. Next, the second section presents the case of Z'mala informal neighborhood in Batna and explains the methodological choices. Then the third section presents the empirical results, analyzing patterns of participation, transformation processes and levels of resident satisfaction. Finally the section, devoted to discussion and conclusion, summarizes the main findings, calls for greater citizen involvement and highlights the need to improve quality of life through inclusive urban planning. It also examines the implications of the findings for urban policies, focusing on the conditions required to guarantee equitable and sustainable development. Before analyzing the fieldwork, it is essential to establish a well-structured theoretical framework. This framework articulates the notions of informal housing, urban resilience, participatory governance and residential satisfaction to better grasp the dynamics of transformation in the Z'mala district.

Urban resilience, participatory governance, and residential satisfaction in the context of informal housing in Algeria

In Algerian cities, urban development is marked by rapid, often chaotic dynamics, linked to growing demographic pressure and structural deficiencies in planning arrangements (Belguidoum, Cattedra & Iraki, 2015). In this context, urban vulnerabilities are multiplying, manifesting themselves in a lack of basic services, land insecurity, environmental risks (flooding, insalubrity) and socio-spatial marginalization, illustrating the processes of urban exclusion described by Castells (1977) and Davis (2006). These factors favor the emergence of informal settlements, produced by processes of self-building, land exclusion and the reproduction of social inequalities in space. Far from being simply marginal or illegal zones, these urban fabrics represent a pragmatic solution to the inequalities of access to urbanized land and the dysfunctions of public policy. They represent another form of urbanity based on solidarity, self-organization, gradual constructive progress and territorial resilience (Roy, 2005 ; Bayat, 2010). Aware of these stakes, and faced with the challenges posed by uncontrolled urbanization and the scale of informal housing, the Algerian authorities have launched a major urban restructuring program framed by Law no. 08-15 of July 20, 2008 relating to development and urban planning regulations (People's Democratic Republic of Algeria, 2008). This law aims to establish a legal framework for integrated urban planning, including the regularization of informal housing, the rehabilitation of precarious neighborhoods, and citizen participation in planning dynamics throughout the country.

This regulatory approach is part of a wider theoretical debate that fundamentally redefines the nature of informal housing. Contemporary research, notably the work of Dovey (2025), emphasizes that "informality constitutes an original form (ur-form) of urbanity", and should no longer be perceived as a simple deviance or anomaly of planning, but as a constitutive mode of urban production. These spaces should therefore be seen as territories of social innovation, where the boundaries between legality, institutional tolerance and self-organization are constantly being negotiated. From this point of view, informal housing is seen as a modality of bottom-up urbanization, revealing the adaptive and creative capacities of marginalized groups. As stated by Shrestha, Gurran and Maalsen (2021), these forms of housing, can reduced to precariousness, are often based on resilient practices of occupation and consolidation, combining "physical precariousness and social stability" within systems of self-organization that are both flexible and robust. All this process gives rise to hybrid arrangements between local populations and authorities, where negotiated forms of life are co-constructed, often outside formal normative frameworks.

In this framework, the concept of urban resilience has emerged as an essential analytical framework for understanding how the inhabitants of informal housing neighborhoods adapt, resist and transform in the face of multiple vulnerabilities, whether physical, social, institutional, economic or environmental. In Meerow et al (2016) point out, resilience is not limited to the ability to absorb shocks: it also implies the capacity to transform existing spatial and social structures in response to crises.

Over time, this approach has undergone several improvement by more recent work, which emphasizes the need to consider local dynamics of learning, community organization and adaptive governance (Khalfallah & Amrane, 2023; Leulmi, Lazri & Abdelkebir, 2023). In Algerian, this resilience urban is reflected in the persistence of social ties, the continuity of collective practices, and a strong attachment to places, despite the absence or inadequacy of

public facilities and services. Where state institutions are often perceived as distant or even failing, residents develop forms of self-organization and civic engagement that enable them not only to survive, but also to transform their living environment. The Active participation irregularization processes, co-design of rehabilitation projects and co-management of public spaces become tools of action through which communities strengthen their collective resilience (Satterthwaite et al., 2020).

Today, participatory governance and co-production in urban areas are key levers for the sustainable integration of informal housing. According to Fung (2006), participatory governance is based on the direct participation of citizens in determining public policies. In Algeria, this dynamic is reflected in institutionalized forms of involvement of residents in land organization, co-design of development projects and joint management of community facilities. These practices go beyond formal consultations to establish genuine co-decision mechanisms, where residents' voices are taken into account in the choices that shape their living environment (Saidani, Kalla & Bendib, 2023). Thus, public consultations prior to demolitions, negotiated agreements on façade improvements or even the partial legalization of housing illustrate a growing desire to recognize residents as co-actors in urban production (Lemkhalti & Khalfallah, 2022). The transition from top-down planning to a collaborative logic establishes co-production as a strategic tool for adapting, mediating and legitimizing urban transformations, particularly in contexts marked by informality and institutional fragmentation.

Residential satisfaction is an essential indicator for assessing the perceived quality of urban transformations, particularly in informal settlements. However, this notion remains fundamentally subjective and difficult to define in a universal way, as it depends so much on individual perceptions, which are themselves influenced by residential paths, socio-economic conditions and the specific expectations of residents. Indeed, it is not limited to material improvements such as roads, lighting or technical networks, but also encompasses fundamental immaterial dimensions: a feeling of recognition, regained dignity, residential security and social appreciation (Sirgy & Cornwell, 2002). All These elements contribute to a subjective sense of well-being that goes beyond mere compliance with urban norms. However, the results observed in several contexts remain ambivalent. Residents' overall satisfaction often remains limited, even after substantial interventions. The paradox of regularization, as formulated by Payne, Durand-Lasserve and Rakodi (2009), highlights a gap between legal recognition of housing and the actual feelings of residents. Obtaining a title deed, in the absence of improved local services, a quality visual environment or inclusive local governance, is not enough to guarantee residential well-being. This observation highlights the limits of a purely technical-administrative approach to urban integration. Too often perceived as a universal solution, land regularization can, on the contrary, reinforce certain inequalities if it is not accompanied by social and spatial rebalancing. In front of this big challenge, we need to adopt a more integrated vision, based on the equitable redistribution of urban resources, the continuous improvement of basic services, and the implementation of mechanisms for the active participation of residents. As Soja (2010) reminds us, fair spatial planning is an essential condition for ensuring inclusive and sustainable urbanity. In Algeria, this complexity is accentuated by the absence of systematic surveys of residential satisfaction in informal settlements, making empirical assessment difficult. This is due in particular to the multidimensional and contextual nature of the concept, in a country marked by a heavy colonial heritage, unfinished regularization policies and urban transformations often far removed from actual usage.

In short, the Algerian experience shows that informal housing is neither a residue nor a failure, but an urban system in its own right, conveying territorial intelligence. Successful regularization requires recognition of this resilience, as well as genuinely participative governance and sustained attention to resident satisfaction. The informal economy can thus become a lever for urban innovation, spatial justice and inclusive transformation, provided it is supported by a strong political will and appropriate institutional tools..

From Definition to Systemic Articulation: Towards an Integrated Model of Urban Transformation

From the conceptual foundations outlined above, it is now important to observe how these dimensions are materialized in residents' practices. In the face of these vulnerabilities, residents, as local actors, deploy urban resilience strategies through community-based adaptation, spontaneous investment and the ongoing pursuit of land security. These citizen initiatives reveal a form of territorial intelligence, which often precedes institutional intervention (Meerow et al., 2016). such as municipalities, and public policies based on Law 08-15, intervene in the logic of regulating or normalizing these spaces, often in a delayed or vertical manner. Only by integrating the principles of participatory governance can these policies respond appropriately to the real needs of local residents. The implementation of public consultations, negotiated regularizations and co-production processes enables a better articulation between institutional dynamics and local aspirations (Terdoo, 2024). When effectively implemented, this inclusive governance strengthens community resilience, legitimizes spontaneous investment and establishes a more stable framework for housing improvement. These cooperative dynamics lead to tangible

physical transformations in the urban fabric: renovations, targeted demolitions and the installation of new facilities reconfigure the inhabited space. These interventions, although initiated by public action, are all the more effective as they are part of a dialogue with resident practices. In return, they generate greater residential satisfaction, marked by improved infrastructure, a renewed sense of dignity, social recognition and, more broadly, a higher quality of life. (Figure 1)

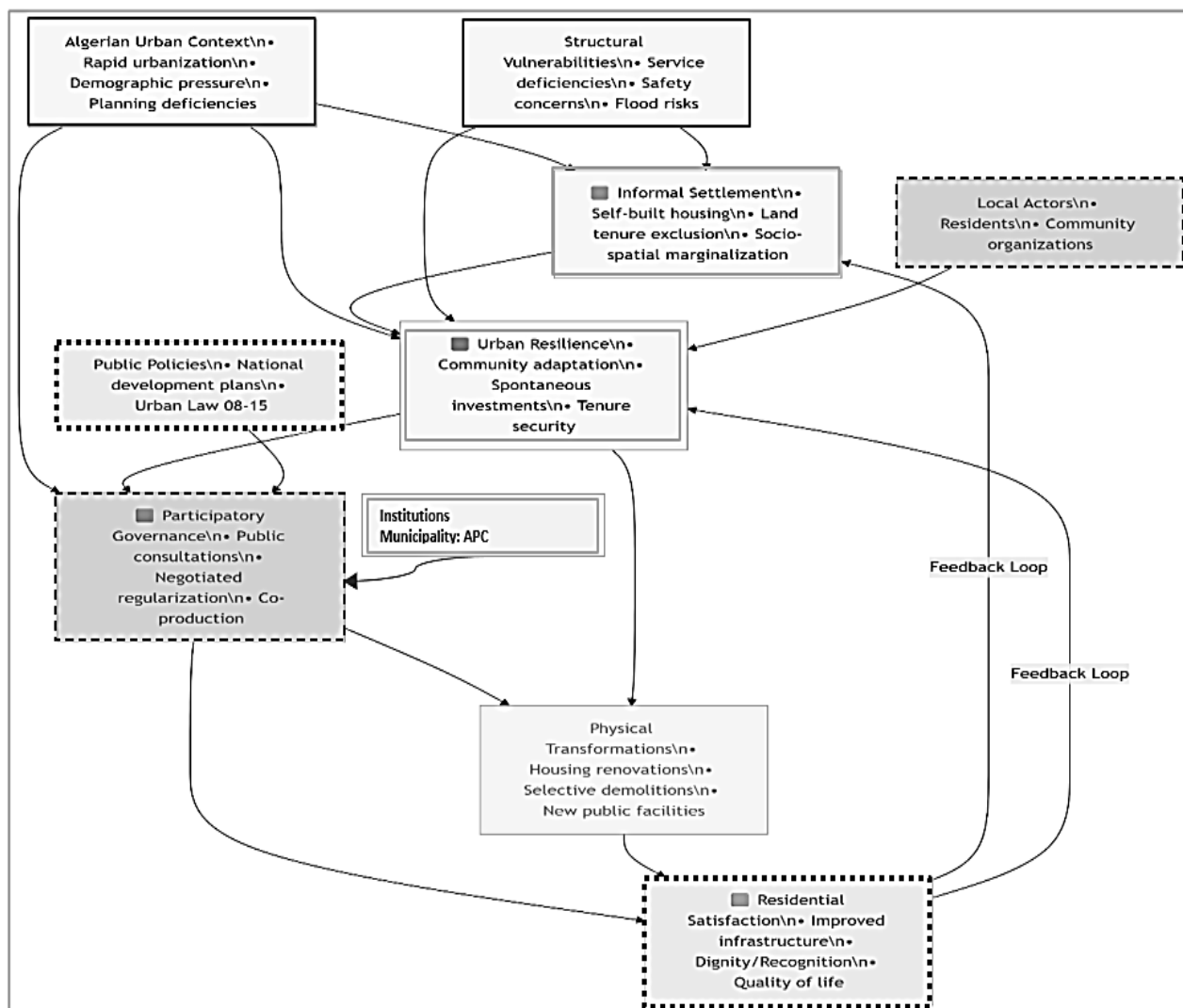


Figure 1. Diagram Feedback loops between the four pillars of inclusive urban transformation.

All the process is not linear, but operates according to a feedback logic: residents' satisfaction fuels their civic commitment, reinforces their participation in decision-making processes, and fosters sustainable urban resilience. The latter, in turn, stabilizes the urban framework and contributes to more firmly rooted and legitimate governance. In this way, a virtuous loop is created, where bottom-up and top-down dynamics work together to co-construct a fairer, more inclusive and more resilient. The four theoretical pillars mobilized in this chapter - informal housing, urban resilience, participatory governance and residential satisfaction - interact according to a systemic logic. By linking them together, we can interpret the requalification of the Z'mala as a bottom-up, co-constructed urban process rooted in residents' practices. Although it was developed outside the legal framework, Z'mala has gradually asserted itself as a territorial player in its own right, actively participating in the dynamics of urban transformation that are shaping the city of Batna. On the basis of this integrated theoretical framework, we present in the following section the methodological approach adopted to empirically analyze the requalification dynamics at work in this neighborhood.

Materials and Methods

Case study

This chapter presents the case of the informal neighborhood Z'mala case located in Batna, a major city in the High Plateaus region, southeast of Algiers, and the capital of the province bearing the same name. As a major urban center in the Aurès region, is facing challenges associated with accelerated urbanization, socioeconomic inequalities, and the rise of unregulated housing. These are the factors that make Batna an appropriate setting for considering participatory regularization (DPAT, 2022). The choice of Z'mala is founded on several considerations. This case clearly illustrates the urban tensions caused by the proliferation of unregulated housing. Located in the immediate vicinity of the city center, Z'mala consists of a cluster of informal dwellings spread along both sides of the El Oued canal, forming a dense and poorly structured urban fabric. Its strategic position along this canal, which runs through the city, makes it a central focus for requalification initiatives aimed at reconciling infrastructure development with residents' expectations.

In this context, the regularization of Z'mala raises major issues of urban resilience, understood as the capacity of a territory to anticipate, withstand, and adapt to social, economic, and environmental disruptions. The participatory approach adopted here serves as a lever to strengthen this resilience by mobilizing local resources, valuing user knowledge, and promoting social inclusion in urban transformation processes.

The Urban Metamorphosis of El Oued Batna: From Informal housing to a New Urban Identity

The urban evolution of the El Oued Batna belt between 2010 and 2019 illustrates a dramatic transformation, marked by the shift from uncontrolled urbanization to a structured and modernized space. The analysis of photographs taken before the development project reveals profound changes in both the landscape and residents' quality of life. In 2010, the urban belt of El Oued Batna exhibited a landscape shaped by spontaneous and unregulated growth. Photographs from that time show dense, disorderly occupation along the canal banks, where precarious housing had proliferated without adherence to urban planning or safety standards (PDAU, 2009). The informal neighborhood, built with various materials, created a labyrinthine urban fabric with narrow alleyways and hard-to-access areas. Additionally, the lack of proper infrastructure worsened living conditions. Sewage systems virtually nonexistent, were leading to stagnant water and unsanitary conditions. Roads, where present, were in poor condition, making transportation difficult especially during rainy seasons. There were no properly designed public spaces, depriving residents of areas for socializing, relaxation, or recreation. The area was perceived as an urban "no man's land," requiring deep intervention to integrate it into the rest of the city. (Figure 2)

In response to the challenges of uncontrolled urbanization and informal housing, Algerian authorities launched a major urban restructuring project under Law No. 08-15 of July 20, 2008, concerning city planning guidelines, as shown in recent studies (Ministry of Housing and Urban Planning, 2008). In Batna, significant urban improvement projects were initiated as part of the 2010–2014 five-year plan, aiming to enhance the city's image and residents' living conditions. Among these projects was the development of the Oued Batna Canal belt, which runs through the city center. However, due to persistent economic and political crises, the project was only completed in 2019. The law sought to rationalize urbanization, eliminate illegal constructions, and promote balanced socio-spatial integration. The project combines several strategic interventions, such as the demolition of informal housing areas, the modernization of infrastructure, and the revitalization of urban areas, to improve the social inclusion of the impacted communities. This comprehensive approach aimed to ensure sustainable and harmonious urban development in addition to improving living conditions, thereby ensuring sustainable and harmonious urban development, as evidenced by this case.

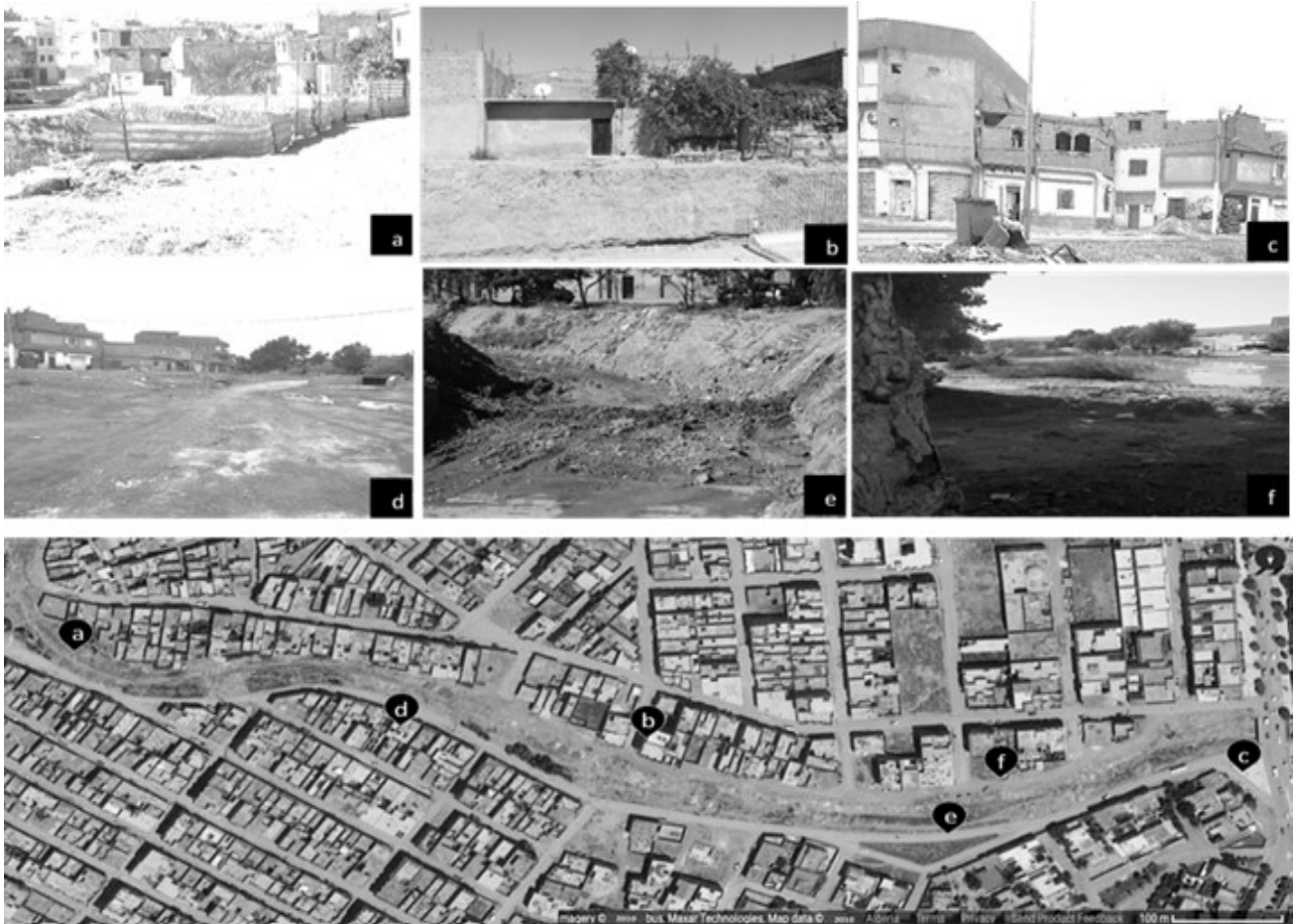


Figure 2. Photos and satellite Map taken Prior to urban transformations. The right bank : **(a)** Primary view showing: Foreground: El Oued Batna canal with inadequate physical barriers and Background: Dense cluster of informal settlements. **(b)** Property for sale along canal bank. **(f)** Recurrent flooding during rainy seasons. The left bank : **(c)** Grouping of informal dwellings. **(d)** Complete lack of formal road infrastructure. **(e)** Natural State Canal View. (Source: Author)

In just fifteen years, El Oued Batna's belt canal area has undergone a theatrical, evolving from a marginalized peripheral zone into a modern neighborhood fully integrated into the city's urban fabric. This urban renewal project has not only revitalized the physical urban space but also significantly improved residents' quality of life, minimized environmental risks, and strengthened connectivity with the rest of the city. The starting point of this transformation was the elimination of informal housing that once defined the area. The old precarious structures, often built without adherence to safety or urban planning standards, were systematically replaced with standardized housing that meets residents' needs. This process was carried out in two main ways: selling existing homes to new owners for reconstruction after demolishing informal structures, or transforming existing homes by adding multiple floors. A key element of this restructuring was securing the canal running through the neighborhood. Previously, this infrastructure was a constant source of unsanitary conditions and a major flood risk during the rainy season. Covering and piping the canal eliminated these hazards while freeing up valuable space, which was then used to expand the road network. This technical intervention simultaneously resolved health and mobility issues. The second phase of the project focused on creating public spaces and upgrading transportation infrastructure. The neighborhood, which once suffered from a severe lack of public amenities, was equipped with landscaped squares, organized parking areas, gardens, and children's playgrounds.

The emergence of new urban spaces completely transformed residents' living environment, providing areas for social interaction and relaxation that foster community cohesion. At the same time, the road network underwent a complete modernization. The formerly narrow and deteriorated streets were explained and redesigned to align with modern urban standards. The addition of roundabouts and optimized traffic flow helped integrate the neighborhood into the city, significantly reducing travel times to downtown and other districts. these

transformation have significantly increased the neighborhoods residential and economic potential. Actually image contrasts sharply with its recent past, unveiling a transformed urban landscape where orderly tree-lined streets, renovated buildings, and well-maintained green spaces harmoniously coexist. Revel's new modern multi-story residential buildings now stand alongside tastefully restored traditional homes, some of which have been expanded with seamlessly integrated additional floors. This well-balanced architectural mix creates a cohesive urban fabric where old and new blend elegantly. The growth of a dynamic commercial and professional sector further enhances this revitalization. These Modern infrastructure— from LED lighting to waste collection systems, fast lanes, and safer intersections completes this new identity, offering residents a functional and pleasant living environment. This urban transformation, both architectural and social, has allowed the neighborhood to forge a unique identity a skillful balance between urban modernity and the preservation of its original character. Today, the site stands as a strong model of successful urban renewal, where every intervention has helped rebuild social bonds while enhancing quality of life. This event powerfully demonstrates how a holistic approach can breathe new life into a community while preserving its soul. (Figure 3)



Figure 3. A Satellite mapping and redevelopment plan for informal settlements along the rehabilitated canal.

A photo taken of part of the neighborhood showing: **(a)** Construction of new multi-storey houses after demolition of old ones. **(b)** Rental for residence, professional and commercial activity. **(c)** A renovated house on the right and construction of another floor for the house on the left. **(d)** **(e)** A street lighting, easements for household waste and a highway. **(f)** A public garden **(g)** A panoramic view of the entrance to the informal settlement after the completion of the development works. **(h)** A Parking area. **(i)** The neighborhood is growing upward with new construction. (Source: Author)

Method

This chapter adopts a qualitative and empirical approach to analyze the extent to which participatory regularization influences urban resilience, governance efficiency, and residential satisfaction in the informal neighborhood of Z'mala in Batna. The study is framed within a "Knowledge, Attitudes, and Practices" (KAP) approach, based on the typology proposed by Launiala (2009), which is recognized for its relevance in analyzing complex social behaviors. It also draws on the methodological guidelines formulated by UN-Habitat (2023) regarding the inclusive transformation of informal housing.

To grasp the diversity of dynamics at play in this informal neighborhood, a mixed-method approach combining quantitative and qualitative data was adopted. The fieldwork was conducted over two years (2022–2024), as part of a retrospective study on the effects of the regularization policies implemented since 2019. Two data collection tools were used: a survey questionnaire administered to a representative random sample of residents, and semi-structured interviews conducted with about half of the households living along the informal housing strip bordering the redeveloped, El Oued Batna's belt canal.

To elaborate the satisfaction questionnaire, we chose for closed-ended questions using a five-point Likert scale, where a score of one reflects a very low level of satisfaction and a score of five reflects a high level of satisfaction.

To assess residential satisfaction, five key quality-of-life indicators were chosen based on (Chen, Luh, Hu, & Shan, 2023): safety, visual atmosphere, local commerce, basic infrastructure, and public spaces. The safety indicator refers to the perception of security in our neighborhood, comprising the presence of police patrols and adequate street lighting. The visual atmosphere takes into account the general appearance of the neighborhood, such as street cleanliness and the aesthetics of buildings. Local commerce is assessed based on accessibility and the quality of essential services. Thus, based infrastructure includes potable water networks, public lighting, roadways, and sanitation systems. Lastly, public spaces refer to the quality and accessibility of recreational and leisure areas such as parks, playgrounds, or public squares.

Semi-structured interviews were conducted with nearly half of the neighborhood's households, using an interview guide structured around the main urban reforms. These reforms include land regularization, which covers the process of legalizing informal constructions, as well as administrative procedures and associated costs; the topic of sale, which explores residents' intentions to sell their property, their motivations, and encountered obstacles; renovation, which focuses on home improvement works (costs, materials, effects on quality of life); the construction of new floors, analyzed through residents' motivations and the impact on neighborhood density; demolition-reconstruction, involving the replacement of precarious housing with new buildings, with special attention paid to financial implications and effects on the social fabric; change of use, meaning the transformation of housing into commercial or professional spaces, their motivations, and their effects on the local economy; finally, rental, studied through the residential, commercial, or professional uses of housing, the income generated, and its impact on the community.

The collected data were processed using a rigorous methodology with the SPSS software. The analysis began with a descriptive statistical study aimed at characterizing the sociodemographic profiles of participants (age, gender) and evaluating general trends in satisfaction, thus providing a clear synthesis of the results. The study then focused on correlation analyses to examine the relationships between different variables, notably the effect of housing regularization on residents' satisfaction. This approach helped highlight determining factors such as the quality of infrastructure and access to basic services. In parallel, thematic analysis of the qualitative interview data brought out residents' main concerns and subjective perceptions while shedding light on the tangible impacts of redevelopment projects on their daily lives.

Results

Results of household interviews

The results of this study highlight the profound transformations that have taken place in the Z'mala district as a result of the urban redevelopment initiative. A significant proportion of informal housing has been regularized - almost two out of every three dwellings - representing a significant step forward in their integration into the formal urban fabric. This situation clearly illustrates how informal housing, initially conceived as a pragmatic response to the shortcomings of urban planning, can gradually be integrated into the logic of the formal city through regularization policies.

Despite this progress, just under a third of dwellings have undergone substantial physical transformation, including renovation, demolition or change of use. This contrast highlights the complex interplay between regulatory arrangements and the ability of residents to undertake major improvements to their property, focusing on the multiple challenges associated with urban upgrading projects. It also shows that regularization, while indispensable, is not a sufficient lever in itself: its effectiveness remains strongly conditioned by households' resources and capacity for action.

Facade renovations were carried out in around one in five dwellings, reflecting a form of bottom-up urban resilience, where the initiative comes not from the institution but from the residents themselves in the form of self-organization, mobilizing their networks, know-how and attachment to place to improve the aesthetic and functional appearance of their property after regularization. A minority of owners representing less than one in ten dwellings, chose to demolish their existing structure to build a new multi-storey building, indicating a broader trend towards spontaneous densification and modernization of the built fabric.

Significantly, more than a quarter of dwellings have been converted for commercial use, while only a tiny fraction have been allocated for professional use, revealing a shift towards local economic activities. These reforms also reflect a form of resident participation in the urban project, negotiated and contextualized on the basis of the diversity of strategies implemented by residents to adapt and take advantage of the opportunities imposed by the local APC authorities and created by the redevelopment project (Figure 4).

These results highlight the concrete impact of the redevelopment project on the physical and socio-economic dynamics of the neighborhood. The important role of land regularization as a catalyst for real estate investment underscores its importance in fostering resident involvement and encouraging improvements to the built environment. However, regularization alone does not guarantee transformation, and the relatively low rates of renovation and demolition suggest the need for support schemes. may be necessary to enable a greater number of households to engage in high-impact transformation projects. All by emphasizing the interplay between regulatory frameworks and the local resilience of residents, this study sheds valuable light on the complexities of urban requalification in informal settlements, while offering a nuanced reading of trajectories towards sustainable urban development.

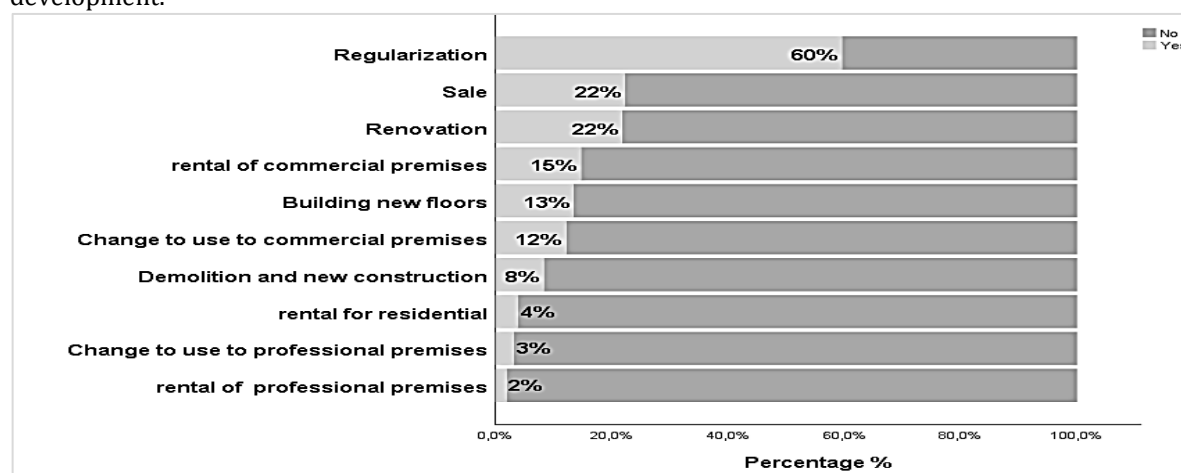


Figure 4. The distribution of informal housing according to the reforms made by their owner and percentage of informal housing reformed (Source: Author)

The four main urban transformations - namely renovations, property transactions, vertical extensions (adding floors) and demolition-reconstruction projects - proved significantly more frequent in dwellings benefiting from formal land regularization, as illustrated in Figure 5. This finding confirms that bottom-up transformation dynamics are activated when the legal conditions for securing them are met.

The analysis reveals significant differences between regularized and non-regularized properties. Dwellings with legal status are demolished and rebuilt much more frequently, vertical extensions are much more widespread, property transactions are more sustained, and renovations are more numerous. These considerable differences empirically validate the idea that legal security stimulates residential investment logics and transforms housing, once perceived as a mere means of subsistence, into a valuable asset on the real estate market. These results confirm the observations of Frediani, Cociña and Roche (2023), according to whom the regularization and securitization of land in informal settlements encourages residents to invest in their housing and helps transform it into a valued market asset, while improving living conditions and human development.

The data show that only residences with full regularization status (also known as “Yes/Yes”) seem to be able to benefit from this transformative dynamic. Conversely, partial regularization status (either “Yes/No” or “No/Yes”) shows very limited effects, as evidenced by the scarcity of cases of vertical extension observed in these circumstances, indicating an even more timid appropriation of the opportunities offered by regularization.

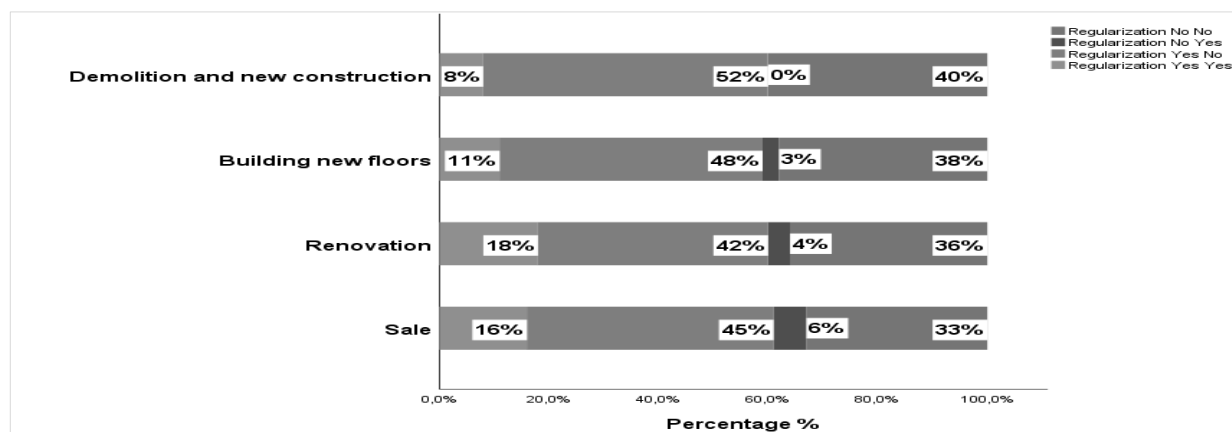


Figure 5. Urban Transformation Rates by Land Regularization Status. (Source: Author)

Finally, figure 6 presents the correlation analysis presented in the graphical correlation matrix between the five main urban transformation indicators (Table.1), highlighting several significant trends. Title regularization shows a positive impact on residential investment, with moderate but significant correlations between regularization and renovation, storey addition and demolition-reconstruction. These findings suggest that legal certainty encourages homeowners to improve the exterior appearance of their homes.

Moreover, there is a strong correlation between sales and demolitions and remodeling, suggesting that new buyers often prefer ambitious remodeling projects over straightforward renovations. There is a strong correlation between vertical expansion and renovation, suggesting an integrated modernization strategy.

However, no significant correlation was found between regularization and sale, nor between sale and renovation, confirming that regularization does not necessarily lead to a transactional dynamic, and that new owners may be less inclined to undertake work. After all, vertical extension and demolition-reconstruction seem to constitute two distinct dynamics.

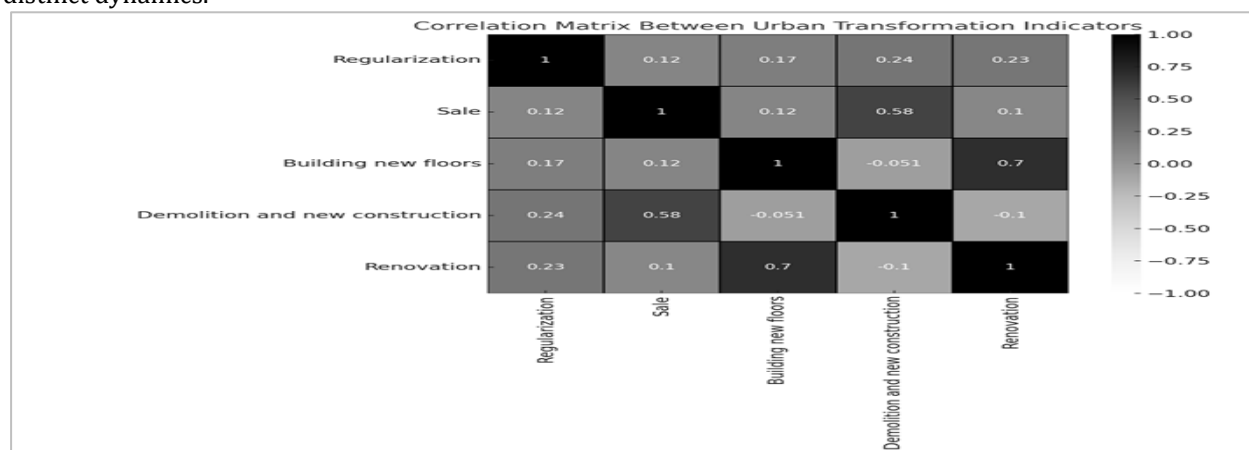


Figure 6. The graphical correlation matrix between the five main indicators of urban transformation.

Table1: Correlations between indicators

Variable		Regularization	Sale	Building new floors	Demolition and new construction	Renovation
Regularization	Pearson correlation	1	.120	.169*	.240	.228
	Sig. (bilatérale)		.201	.045	.004	0.007
Sale	Pearson correlation	.120	1	.124	.579	.105
	Sig. (bilatérale)	.201		.166	.000	.243
Renovation	Pearson correlation	.228	.105	.702	-.103	1
	Sig. (bilatérale)	0.007	.243	.000	.201	
Building new floors	Pearson correlation	.169*	.124	1	-.051	.702
	Sig. (bilatérale)	.045	.166		.527	.000
Demolition and new construction	Pearson correlation	.240	.579	-.051	1	-.103
	Sig. (bilatérale)	.004	.000	.527		.201

* The correlation is significant at the 0.05 level. (Source: Author).

Results of the Satisfaction Survey

The representative sample of participants was randomly selected for the survey in order to determine the socio-demographic characteristics of the neighborhood. a strong representation of young adults and relative gender parity. This demographic structure suggests that a population is actively involved in the dynamics of appropriating space, and residential projection is what drives the perception of urban transformation. The equal distribution of men and women makes it possible to analyze living practices that often differ according to gender, particularly in terms of perceived safety, management of public space and accessibility of services. To better understand the ways in which residents express their resilience, commitment and satisfaction, these framing elements provide an interpretative basis.

The assessment of residential satisfaction is based on five essential dimensions of perceived quality of life: safety, visual ambience of the neighborhood, accessibility to shops, quality of basic infrastructure and presence of public spaces. These indicators provide a qualitative reading of urban impact, based not on technical standards, but on the feelings and perceptions of residents. In order to interpret these assessments, three evaluation thresholds have been defined: a satisfactory level, a perfectible level, and a level deemed intolerable. This approach places residents' lived experience at the heart of the analysis, viewing satisfaction as an indicator of the social effects of urban transformation.

The results, based on the diagram (Figure 7) and the summary table2 , reveal an overall low level of satisfaction. Indicators relating to safety and accessibility to shops reach a level deemed perfectible, while the other dimensions of quality of life show results below the minimum acceptable threshold. Fewer than half of residents expressed an overall sense of satisfaction, and only a minority of residents declared themselves satisfied with all five dimensions simultaneously. This finding highlights a significant gap between the regularization efforts made in the neighborhood and the benefits actually perceived by residents. These data illustrate what the literature refers to as the "regularization paradox" (Payne, Durand-Lasserve & Rakodi, 2009): legal security of housing is not in itself sufficient to produce a better quality of life. Residential satisfaction does not depend solely on the possession of a title, but on a coherent, functional and dignified urban environment. It is therefore a strategic qualitative indicator, enabling us to assess the social relevance of urban policies beyond their regulatory scope.

Table 2. Table of frequencies and satisfaction and dissatisfaction rates for the five indicators studied.

Evaluation criteria	Satisfied	Dissatisfied	Neither satisfied nor dissatisfied
	Number (%)	Number (%)	Number (%)
Safety	224 (64.0%)	26 (7.4%)	100 (28.6%)
Basic infrastructures	167 (47.7%)	64 (18.3%)	119 (34.0%)
Public spaces	79 (22.6%)	49 (14.0%)	222 (63.4%)
Visual ambience	164 (46.9%)	97 (27.7%)	89 (25.4%)
Convenience stores	179 (51.1%)	70 (20.0%)	101 (28.9%)

(Source: Author)

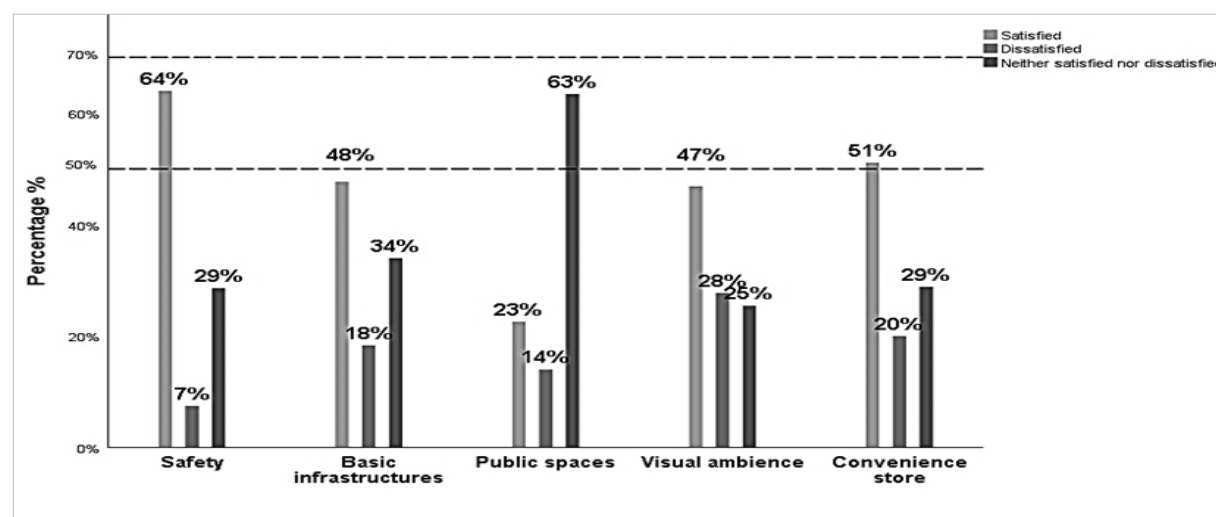


Figure 7. Diagram of satisfaction rates for the five indicators compared to satisfaction rate thresholds.
(Source: Author)

Discussion and Conclusion

The informal housing in Algeria illustrates the trade-offs between forced evictions and participatory regularization, while the Batna canal project demonstrates how securing land tenure fostered the rise of urban resilience based on encouraging residents to improve their housing themselves. Their management is difficult due to the poverty of the residents and the absence of basic infrastructure (DPAT, 2022): landfills, water access networks, roads, etc. The lack of roads makes them inaccessible to the local population. The lack of roads makes them inaccessible to household waste collection vehicles. Added to this is the insecurity caused by the presence of organized gangs. The best solution, albeit the most costly, remains demolition and relocation of the inhabitants to social housing on the outskirts.

In the case of Z'mala, the informal housing is located close to the town center, making it impossible to persuade residents to move to the outskirts. A development project, the regularization of more than half of the dwellings, combined with the effective participation of the residents through the renovation of their homes or the construction of new ones, were the two best solutions for integrating this informal settlement and transforming it into a dynamic hub of commercial and professional activity. What's more, it has become a major landmark in the city of Batna. More than a fifth of residents have been able to sell their homes at exorbitant prices, whereas previously they had no value at all. Regularization has had a significant impact on demolition by encouraging sales. The informal housing is gradually beginning to disappear, making way for beautiful new constructions.

Despite these changes and improvements, the average overall satisfaction rate remains intolerable. As Chiodelli & Gentili (2021) demonstrate through comparative cases, regularization alone is often not enough to solve deeper quality-of-life issues, in the absence of parallel investments in social services and infrastructure. This paradox of regularization helps explain why even successful land programs, such as the one in Batna, can result in limited gains in terms of satisfaction. The majority of complaints concern the quality of public spaces and the visual atmosphere. Indeed, this district, now a magnet for commercial and professional activities, is very busy, which calls for an improvement in its image.

The development of the El Oued canal in Batna has demonstrated that a participatory approach can transform an urban development project into an opportunity for socio-economic growth. The satisfaction of homeowners, whose informal dwellings were spared demolition, highlights the importance of balancing urbanization and social justice. Thanks to collaborative governance, the project - despite being more than fifteen years behind schedule - was completed, while rising land values encouraged stakeholders to become actively involved in maximizing the project's benefits.

This case study reveals several key lessons for the management of informal settlements. Firstly, involving residents in the process of regularization and urban integration is essential to ensure sustainable and widely accepted solutions. Secondly, the legalization of informal structures is not limited to administrative recognition - it paves the way for more far-reaching transformations, including the gradual disappearance of substandard housing in favor of more dignified, permanent dwellings. As shown by the Egyptian case analyzed by Bremer and Bhuiyan (2014), where community participation and investment in local infrastructure have led to significant improvements in informal areas.

To consolidate these gains, public authorities need to support this dynamic by strengthening basic infrastructure and services (health centers, schools, public spaces, etc.). In addition, financial incentives, such as subsidies for facade renovation or access to low-interest loans, could encourage homeowners to improve their living conditions. Finally, demolition and reconstruction initiated by the residents themselves, with the support of the State, represents a win-win solution: it promotes local employment, enhances the urban heritage, and gradually eliminates informal settlements, offering a more dignified alternative to the often stigmatized social housing. As demonstrated in the African (Huchzermeyer, 2009) and South Asian (Patel, Baptist & D'Cruz, 2012) contexts, this model - while imperfect - offers transferable lessons to cities facing informal sprawl through participatory regularization. It proves that a balanced urban policy - combining regularization, citizen participation and public investment - is the key to inclusive and sustainable urbanization.

Acknowledgements

I would like to express my deepest gratitude to the APC (People's Municipal Assembly) of the city of Batna, Algeria, as well as to the residents of the Z'mala neighborhood who participated in the interviews during my fieldwork. Their unwavering support, resources, and invaluable contributions were essential to the success of this work.

Conflict of Interests

The author declares no conflict of interest.

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Chapter 5

The Potential of Drones in Documenting and Preserving Cultural Heritage in Bahrain

* Alawi Alsari, Prof. Dr. Islam Elghonaimy

Introduction

Cultural heritage sites reflect important links in the history, identity, and legacy of a country (Qadir et al., 2022). There are old settlements, forts, and mosques in Bahrain which, if maintained well, could continue the long history of those countries. At the same time, most heritage sites face severe risks brought about by environmental impacts, urban growth, and neglect (Qadir et al., 2022). Traditional methods of documentation and conservation of such sites very often become limited in capacity, are extremely costly, and carry risks due to the hazards of working in declining structures.

In the last years, drone technology has been well highlighted to solve such problems in the domain of cultural heritage preservation (Zheng et al., 2024). The utilization of drones offers non-destructive, inexpensive ways to capture high-resolution images and generate 3D models of ancient sites, including those that are challenging to access. They allow for fast and accurate documentation, thus giving valuable support to conservation and creating a digital record for future generations (Samadzadegan et al., 2023). These gains in the said fields notwithstanding, the cultural heritage in Bahrain remains restricted to the legal, technical, and operational obstacles of using drones.

This will seek to show the potential of drones in the preservation of Bahrain's cultural heritage. Significant opportunities and challenges regarding the implementation of drones in heritage documentation will be underlined using drone usage in a variety of successful case studies and interview analyses with local architects. Additionally, this paper will also propose a workable framework in Bahrain that could help overcome regulatory obstacles toward further improved drone technology and stakeholder collaboration. the housing units of under 60 m² and with no views of green areas, as their households are more prone to depression (Amerio et al., 2020) and, on the other hand, those located in community blocks and with aligned façades, given the difficulties to carry out extensions or alterations. This paper stresses three aspects for this type of housing: the need to consider the orientation of the housing to improve the quality of the indoor and outdoor space; the need for public housing policies for a greater number of rooms to facilitate remote working; and, finally, the importance of functional terraces overlooking green areas.

The importance of Cultural Preservation

Cultural preservation is the protection of cultural heritage for future use. Cultural heritage in itself consists of the tangible and intangible elements that manifest in historical buildings and monuments, traditional practices, languages, forms of knowledge identifying a community-as identified by (Okoli et al., 2023) It is the preservation of these elements that helps to further the sustenance of cultural values and consolidates national identities confronting challenges emanating from globalization, modernization, and urbanization.

The connection to heritage ties the individual with the past and strengthens the sense of belonging, making it also a promoter of social cohesion. According to (Sigmund, 2016), heritage is not necessary but even understood as a symbolic meaning of collective history and identity. Moreover, Cultural heritages play a strong role in both economic and social life even though the majority remains informal, without public protection and without explicit

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How to Cite This Chapter:

Alsari, A., & Elghonaimy, I. (2025). The potential of drones in documenting and preserving cultural heritage in Bahrain. In Rokhsaneh Rahbariyanzad & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 37–44). Cinius Yayınları.

<https://doi.org/10.38027/N5ICCAUA2025EN0029>

management as they are the main institutions that connect history, territory and society, defining the cultural context of social life (Sigmund, 2016).

A vital component of cultural preservation involves the implementation of architectural methodologies aimed at protecting historical edifices and monuments. Such methodologies encompass adaptive reuse, restoration, and conservation, which are essential in preserving the structural integrity and significance of heritage sites. The utilization of architectural strategies is instrumental in confronting the difficulties presented by modernity, particularly the necessity of reconciling preservation efforts with urban development (Okoli et al., 2023). This will help in the conservation of the environment as well as retain the original characteristics of the building, according to (Sigmund, 2016). Adaptive reuse generally involves converting heritage structures to modern use while retaining their historical significance and hence securing a place in current society (Okoli et al., 2023).

Methods of Heritage Preservation

Basic methods of protection of the constructed cultural heritage are restoration and conservation. As explained by (Besana, 2019), it is pointed out that restoration focuses on returning a cultural property to a previous, already defined state by removing alterations or rebuilding missing parts. The early theoretical assumptions initiated by Viollet-le-Duc in the 19th century underlined that restoration works needed paying close attention to preserving at least the initial goals of the authors. The aim of restoration is to preserve the monuments' aesthetic and historical integrity; thus, it considers their stability.

Conservation, on the other hand, means the preservation of the material integrity of heritage sites without any further deterioration of the site itself, without reconstruction or major alteration. The Charter of Venice (1964) and the European Charter of Architectural Heritage (1975) underscore the significance of comprehensive conservation, which combines both the preservation of physical structures and meticulous urban planning (Besana, 2019). Efforts in conservation are founded upon diagnostic methods, encompassing non-invasive assessments to evaluate material composition, identify structural vulnerabilities, and ascertain the historical importance of locations (Besana, 2019). It means restoration and conservation differ in their approach to deal with change and deterioration to retain the spoken historical narration of each heritage site for its being.

The digitization of cultural heritage became one of the current means for preserving tangible and intangible heritage in recent years. With regard to this, (Goussos, 2022) underlines that digitization-3D scanning, virtual reality tours, and digital mapping-provides such a possibility in terms of detailed and accurate documentation and preservation of historical sites and artifacts. It not only preserves a digital archive of inestimable historical and contemporary value for future generations, but also allows for access to cultural heritage on the part of a worldwide community when physical access to sites is severely limited by political, natural, and other obstacles.

Furthermore, digital preservation methodologies protect fragile or deteriorating materials by creating virtual copies that reduce the need to handle the physical material. For instance, digital collections of manuscripts, art, and oral traditions have become crucial to the preservation of cultural heritage (France, 2010). In this regard, digitization has become an integral part of modern preservation strategies, since it allows better access while reducing the possibility of loss due to physical decay or natural disasters (Goussos, 2022).

Drones technology

Most of the common techniques, through which drones realize highly accurate 3D models, involve several shots taken from different angles. (Febro, 2020) has presented how drones are able to deliver highly detailed 3D replicas of the Philippine Baroque churches, hence giving a very effective and non-destructive means of documenting cultural heritage. This is important in the creation of digital recordings that preserve the physical features of the sites, which are very vital for restorations in the future.

1. LiDAR for High Performance

Mounted on unmanned aerial vehicles, LiDAR (Light Detection and Ranging) is a remote sensing method used to examine the surface of the Earth (National Oceanic and Atmospheric Administration, 2024). This provides a finer alternative to photogrammetry, particularly for areas covered with vegetation. (Themistocleous, n.d.) highlighted how LiDAR could cut through vegetative cover and create detailed digital terrain models, which is very critical for archaeological sites. LiDAR provides topographical data with a great deal of accuracy that would otherwise not be achievable with photogrammetry.

2. Affordability and Accessibility

It is cost-effective compared to other documentation tools. (Febro, 2020) proved that even small-scale organizations can have easy access to drones for wide usage in faraway or not-well-endowed areas with resources. Affordability by ease of use makes cultural preservation possible to a wide range of users.

3. Supervision and Conservation

Drones have increasingly great importance in the continuous monitoring of heritage sites, enabling the immediate estimation of changes due to various environmental or anthropogenic causes. Quite often, the flights of drones lead to underpinning data for conservation effort and manage the degradation at sites more easily.

4. Limitations and Barriers

Coupled with the innumerable benefits of drones, some of the disadvantages comprise but are not restricted to dependence on the environment. Weather, light, and topography constitute those environmental factors that seriously impact an impact on quality. (Febro, 2020) further indicated that poor weather conditions that involved high wind amidst unfavorable light might result in poor accuracy in the photogrammetric model. Also, LiDAR manages to cut through vegetation, yet it is quite costlier than photogrammetry and hence cannot be applied to all projects.

Materials and Methods

This research adopts a qualitative approach into finding the potential of using Drones in documenting and preserving cultural heritage in Bahrain. Data will be collected through interviews using open ended questions with participants who are involved in general building documentations in Bahrain. This will provide insights into how building documentation is conducted locally and what challenges might face. The interviews were conducted via phone calls for convenience and accessibility.

Additionally, case studies will be collected on successful applications of drones in building documentation, one local case study that have been conducted on Bahrain Fort additionally will be comparing two international case studies for Santo Stefano Church in Italy, and The Deir-e-Kaj caravanserai, located in Qom, Iran. The study considers the technical aspects, the out come achieved and the challenges faced.

This analysis helps to highlight both, the strategies gained from international practices and the local challenges. Throughout the whole study, ethical guidelines were closely followed, including gaining informed consent and protecting participant privacy.

key limitation of this study and its methodology has to do with the relatively low level of access and application of drone technology in Bahrain because of its rather restrictive regulations, hence limiting the number of practical case studies relevant to a local context. In addition, this research is heavy on the interviews with architects and may not fully deliver the technical or operational challenges faced by drone fliers.

Case Study - Santo Stefano Church in Italy

In this study by (Lin et al., 2024), the employment of UAVs integrated with HBIM (Heritage Building Information Management) for recording and rehabilitation of the architectural heritage will be considered for the Santo Stefano Church in Volterra, Italy. Acquisition was made using a DJI Mavic 3 Pro equipped with a Hasselblad high-resolution camera, taking 200 images in low-altitude photogrammetry. Subsequent image processing was made by means of software such as Pix4Dmapper and Photoshop to deliver highly detailed 3D models. It also involves GPS to provide support for measuring the control points with high accuracy. The integration of drone-captured data within the comprehensive 3D model of HBIM was further extended by VR technology for the virtual restitution of the original appearance of the Church.

Results Obtained The accuracy in the flown paths allowed for the realization of a 3D point cloud and virtual reconstruction of Santo Stefano Church for its digital preservation in that state of deterioration. Further immersive VR experiences were possible with this 3D model, thus providing a visual reference both for conservators and the public.

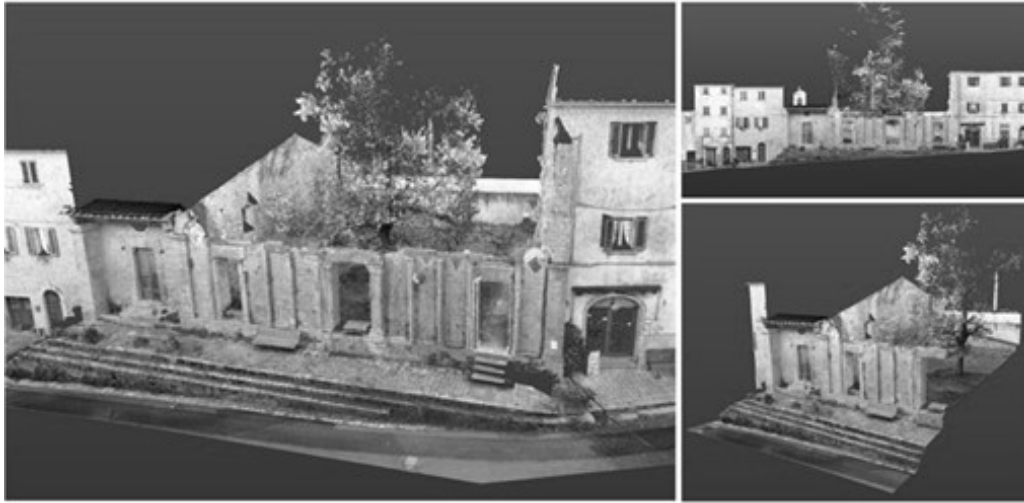


Figure 1. The point cloud of the Santo Stefano Church. (Lin et al., 2024).

Further, integrating the HBIM model allowed the analysis of such structural issues as wall tilting and foundation subsidence, which also supported both current and future restoration efforts. Another output was the development of a family library in HBIM by recording key architectural elements useful in heritage conservation.

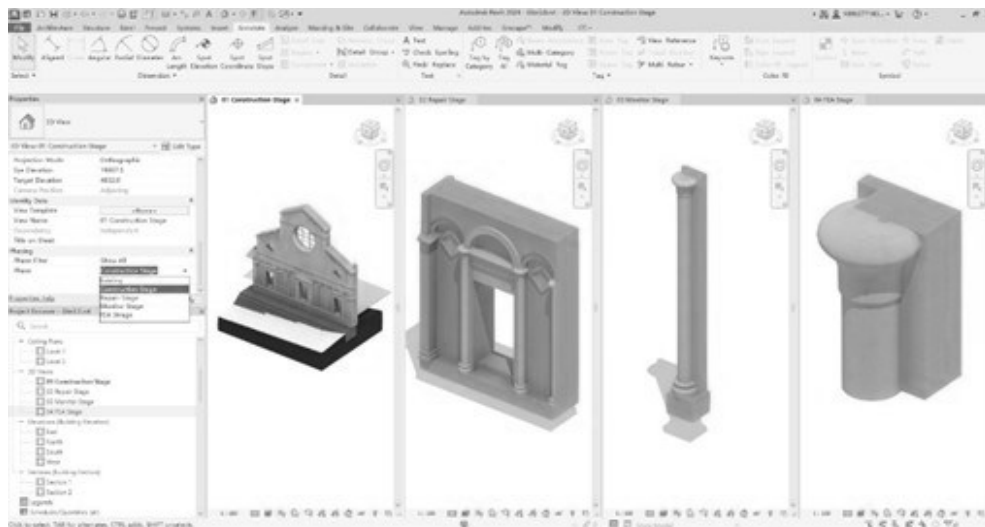


Figure 2. Family library in BIM for Santo Stefano Church made by (Lin et al., 2024).

Challenges Encountered The project has to face big difficulties: from the scarcity of historical records which compelled the research group to rely very much on data derived from drones and to make partial compensation with archetypes known for the period concerned, to the very bad conditions of weather and light that made the photogrammetric process very complicated, demanding heavy planning and correction of images. One more technical problem has been about the precision of the 3D model, partially solved by the integration of GPS technology with uncertain adjustment of point clouds.

Case Study - Deir-e-Kaj caravanserai in Qom, Iran

In a study of the Deir-e-Kaj caravanserai in Qom, Iran by (Samadzadegan et al., 2023) , a combination of UAV-based photogrammetry and multi-view imaging techniques was employed for 3D documentation. The quadcopter drone used was equipped with a 12-megapixel camera, mounted on a three-axis gimbal. The drone captured nadir, horizontal, and oblique images, allowing for comprehensive data acquisition of the site. The data processing was carried out using Structure from Motion (SfM) techniques in Zephyr software to generate a dense point cloud and create a detailed 3D model. The use of Ground Control Points (GCPs) ensured that the model achieved high precision with a ± 1 cm accuracy.



Figure 3. Approximate position of targets on the caravanserai's enclosure used by the Drone(Samadzadegan et al., 2023)

Outcomes Achieved, The use of drones in this study led to the creation of a highly accurate and textured 3D model of the caravanserai, which could be used for conservation and restoration planning. The multi-view imaging approach allowed for the documentation of both the exterior and interior spaces, including areas that were inaccessible due to physical damage and illegal excavations. The 3D model preserved metric and geometric data, which are crucial for long-term preservation and research. Additionally, this model can be integrated into Geographic Information Systems (GIS) and used in virtual reality applications, expanding the potential for heritage documentation and public engagement.



Figure 4. Bird's eye view of the textured 3D model (Samadzadegan et al., 2023)

Several challenges were encountered during the documentation process. First, the site's physical deterioration and the presence of illegal excavations made it impossible to use traditional survey methods. UAV-based surveys were necessary to overcome these physical barriers. Additionally, there were technical issues related to ensuring adequate image coverage, particularly in areas with shadows or complex structures. To address this, oblique imaging was introduced to reduce gaps in the data and avoid dark spots in the 3D model. Another challenge was ensuring the precision of the model, which was tackled by employing GCPs and using software to fine-tune the accuracy of the reconstruction.

Case Study – Bahrain Fort

The Bahrain Fort study by (Chiabrando et al., 2022) introduced a state-of-the-art solution for the 3D documentation of the site with the help of UAV photogrammetry, SLAM-based MMS, and TLS. The photogrammetry by UAV had to do with flying the so-called drone-aspect sensor, the DJI Phantom 4 Pro, in nadiral and oblique images at different altitudes with regards to documenting the surroundings and structure of the fort. The proposed system used close-range photogrammetry for minute detail capture, SLAM indoors, and provided dense point clouds from both techniques, processed in Agisoft Metashape and Geoslam Hub, respectively, with GCPs in each for ensuring the accuracy of point cloud.

Results Achieved Only by integrating various imaging techniques could a very accurate high-resolution 3D model of the Qal'at al-Bahrain fort be obtained. Data supplied valuable metric information for the conservation project with very accurate documentation of the structural details and relief of the fort. The obtained model showed a good level of accuracy (± 2 cm) for applications in future restorations.

Besides this, the multi-sensor approach overcame various documentation challenges due to inaccessible or internally complex structures while providing further support to archaeological analyses and virtual heritage applications.

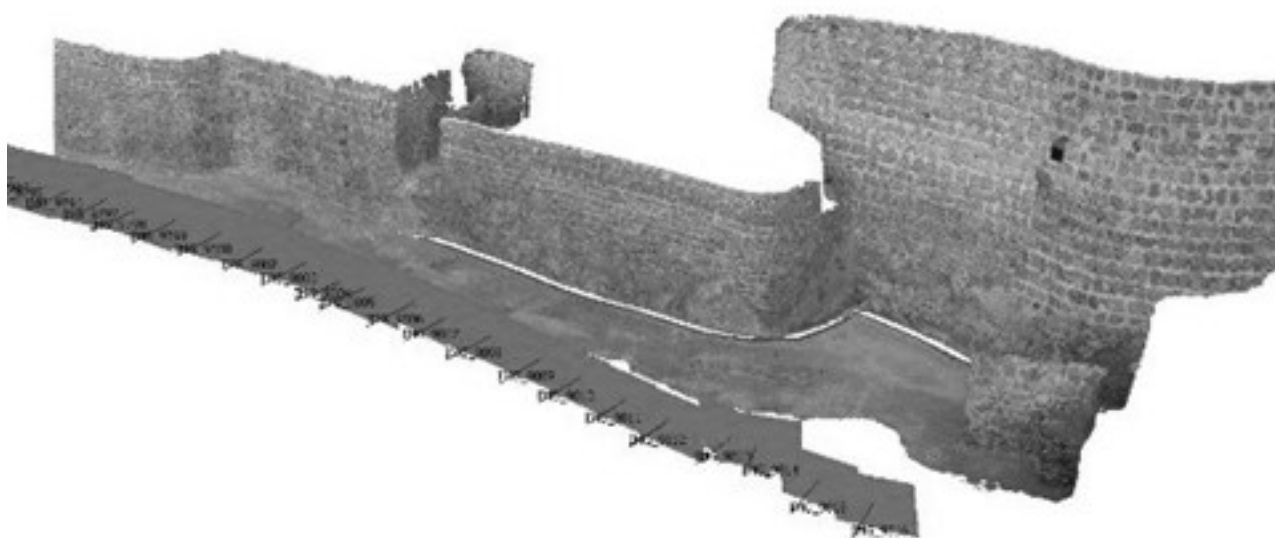


Figure 5. Close-range photogrammetric point cloud model, interior wall of Qal'at al-Bahrain. (Chiabrando et al., 2022)

Challenges Presented The project faced many technical and environmental challenges. Under ideal situations of severe illuminations, high temperatures, wind, and humidity, the possible time to capture the data was greatly reduced, limiting activities to early morning. Moreover, the variety of surface types and the ever-changing lighting situations developed a critical situation for image acquisition, especially regarding photogrammetric purposes. Radiometric quality problems and shadowing effects also caused additional problems, affecting the homogeneity of UAV photogrammetry data. There were also complications on how to merge and consolidate some data from several sources to ensure consistency and integrity.

Discussion and Conclusion

Interviews with architects shows how these professionals view the application of drones for documentation purposes in building practices, particularly those dealing with heritage sites.

Architects also comprehend the possibilities of drones in supporting and enhancing the accuracy and speed of the processes of building documentation. Most traditional methods include laser measurements and manual mapping, which tend to be way off the mark consistently in terms of accuracy, as this comment reveals.

Meanwhile, drones provide an overview from above, giving much more contextual understanding of the building in its setting, and allowing highly accurate 3D modeling. "Drones will make it possible to shoot over a building, and view and measure things that it's difficult to measure," said one architect. Moreover, drones make it possible to capture regions that are difficult to reach, including rooftops or old buildings with safety risks for a surveyor. The capability of acquiring accurate images of difficult-to-access locations is very useful in heritage documentation, where structural fragility often reduces accessibility.

Despite acknowledging that drones are useful tools for documentation, interviews revealed quite a number of practical difficulties.

One of the respondents reflected that from drones, one can get very high-quality 3D models, but often the files are big and heavy to handle with software and hardware. Another interviewee mentioned that during big projects, at the moment when 3D scanning was performed with the help of drones, all that usually "caused problems in the treatment of data and opening big files, less reliable, and more difficult to use in certain cases".

However, one interviewer suggested that we could use similar approach that Google uses when constructing 3D models for their google maps. They use 3d images that gathered from drones GPS data to construct depth maps in the photos (Brent Daniel, 2022).

Besides that, privacy and legal restrictions become substantial barriers in Bahrain. For flying drones, special permissions are needed, but it faces a limit because of considering the implications on privacy and safety, especially during capturing images of buildings around important areas, like a police station or congested residential areas. The existence of these kinds of regulations also makes practical implementation complicated despite the acknowledged technical benefits. Notwithstanding, everyone agrees that the drones bring added value to the documentation of buildings.

The architects said that drones could present an entirely new view and collect quite different data that would have been impossible or risky to acquire. One of the interviewees underlined that, especially in cases when assessment of the structure's condition is performed with drones before direct human involvement, it enhances safety during site inspections. It allows the enhancement of 3D models, enriching values into a dataset that will be demanded by an architect in restoration planning, primarily when such works become indispensable at historic sites.

Conclusion

The process of utilizing drones for documentation and conservation can be divided into four key stages.

First is the phase of Planning & Regulatory Compliance, underlining that a drone should be flown legally and safely. Permission from the relevant authorities must be granted while addressing issues on privacy and consultancy with various government and heritage stakeholders. The deliverables expected from the said stage are legal clearance for the use of drones and well-defined operational guidelines, while challenges involve delays in getting permits and restricted flying areas.

Second Stage is Data Acquisition, which Capture the site data in detail through drones fitted with photogrammetry and LiDAR. Use of drones to fly over areas inaccessible, coupled with safety operations, assured. This would be foreseen to yield high-resolution 3D models with full site coverage, though it might suffer the same drawbacks regarding bad weather conditions or issues of handling very large files.

Third stage is data process, the captured data must be processed with specialized software, like Pix4D (Lin et al., 2024) and Agisoft (Samadzadegan et al., 2023) (Chiabrande et al., 2022), and data must be integrated into Historic Building Information Modelling, or HBIM (Lin et al., 2024), with the optimization of file size. The expected deliverables are detailed and accurate 3D models for restoration and digital archiving. Handling of large datasets and specific expertise have been a challenge in this phase.

Finally, the stage of Monitoring & Conservation consists of long-term monitoring, publicity outreach through drone surveys, real-time data feedback for conservation, virtual tours, and simulation development. While the goal of this phase is to allow for further documentation with active public involvement via virtual models (Goussos, 2022), a number of disadvantages are seen with this method, including increased operational and continuous technological upgrade costs.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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PART II

Heritage Conservation, Monitoring and Adaptive Reuse

Chapter 6

Authenticity And Users' Experience of 'Traditional' Places

* Manal Khalaf, Layla Karajica

Introduction

This research aims to investigate the importance of authenticity from the perspective of lay people through the case of contemporary 'traditional' cafes in Bahrain. It attempts to answer the question of authenticity and shed light on the positive side of imitations and themed places of traditional architecture as a means of documentation. It discusses these ideas through case studies of contemporary cafes in Bahrain that adapt traditional themes. Through field studies and interviews, it investigates how authentic 'traditional themed cafes' are perceived by their owners, working team and visitors. Based on the findings, the authors here argue that without undermining the importance of authenticity in original heritage sites, imitations and themed places of traditional architecture and interiors could be acknowledged as a means of documentation of cultural heritage that facilitates accessibility to heritage especially to those who are not familiar with the original places.

Authenticity and heritage conservation

The concept of 'authenticity' is rooted in the conservation field and therefore, in order to understand authenticity, it is important to understand it within its context of heritage conservation. The notion of heritage conservation has two major paradigms (Vinas, 2005). The first one, which is known as the classical conservation theory developed in Europe in the 19th century, represents the western view on conservation, focuses on material authenticity and considers the value of heritage objects and places to exist independently of people. This theory was translated in a number of international conservation documents. For example, the Venice Charter (1964) stresses maintaining original material, design and historic accuracy without mentioning non-material, intangible heritage or the value attributed to heritage by local communities (ICOMOS, 1964). Similarly, in practice, the World Heritage Convention (1972), until the 1990s relied heavily on the ideas of material integrity adopted from the Venice Charter (UNESCO, 1972).

The second paradigm, which is known as the contemporary conservation theory, developed gradually during the last two decades of the 20th century. This theory is considered as the people-centered approach where the notion of heritage is rooted in the value and meaning attributed to objects and places by people (Kwanda, 2010). Thus, according to this view, people are the creators of heritage, and they also select what should become heritage. The seeds of this theory started with recognizing cultural diversity, embracing the value of intangible heritage and the views of local societies. It suggests moving away from imposing the Euro-centric understanding of conservation and authenticity on the international community. For example, the Nara Document on Authenticity (1994), implies that material integrity is one of several aspects of authenticity and recognizes that authenticity may lie in tradition, function, spirit, or social meanings and values, not just materials originality (ICOMOS, 1994). On the other hand, the Burra Charter (1979, latest revision 2013) shifted the focus of the assessment of cultural heritage to the notion of 'cultural significance', which includes tangible and intangible values, including community values, meanings and use (Australia ICOMOS, 2013). Accordingly, instead of material driven conservation, value-based conservation became increasingly important internationally. With the recognition of authenticity in terms of experience in the heritage

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How to Cite This Chapter:

Khalaf, M., & Karajica, L. (2025). Authenticity and users' experience of 'traditional' places. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 45–53). Cinius Yayınları.

<https://doi.org/10.38027/N6ICCAUA2025EN0044>

field, the discourse is increasingly revolving around the idea of measuring and testing authenticity especially by national, governmental bodies or international institutions such as UNESCO or ICOMOS (Rakic 2007, 212; Jones 2009; Alivizatou 2012; Bendix 2008; Gentry 2013).

Concepts of authenticity and heritage are closely connected with identity as explained by Smith and Akagawa (2009, 7) stating that 'a key consequence of heritage is that it creates and recreates a sense of inclusion and exclusion'. Gentry (2013), for example, emphasize the 'importance of a sense of place' stressing that there is a 'desire to take authority back from so called 'experts' and return it to individual and community'. Chhabra, Healy, and Sills (2003) highlight that identity and culture are changing by their nature as people travel and migrate taking their culture with them. Therefore, as argued by Wood (2020), culture should be understood as a process of exchange, growing and developing over time and under different circumstances.

In this chapter, particularly traditional places are discussed and thus it was found essential to understand how traditional places are perceived in academic literature. Generally, most scholars highlight the tangible and intangible aspects of traditional places. For example, Ashworth and Graham (2005), stress this stating that "traditional places hold cultural significance, both tangible and intangible, passed down through generations, reflecting a community's identity". Likewise, Fairclough (2008) defines traditional places by connecting them to their cultural heritage that is transmitted over generations in a way that links those places to local identity and memory. This means that in addition to their physical aspects, traditional places embody cultural interpretations and practices that contribute to a community's sense of identity, belonging and endurance (Fairclough, 2008). Similarly, Tilley (2006), emphasizes that traditional places have material and immaterial aspects as those places hold both physical environments (e.g., buildings, landscapes, etc.) and intangible attributes (e.g. knowledge, rituals, etc.) that give them cultural meanings and values.

While the importance of authenticity of the tangible aspect is well established in literature, there are voices which argue that the fakeness of identical reconstructions and imitations can also allow users to experience a sense of authenticity (Piazzoni, 2020). In fact, scholars of heritage have increasingly emphasized that material authenticity is not as significant to lay people as the meanings they attribute to traditional places and landscapes (Knudsen and Waade 2010; Holtorf 2013; Rickly-Boyd 2013). According to such views, the notion of "fakeness" contests classical views of authenticity in heritage by suggesting that the value of imitations is rooted in their ability to evoke a sense of authenticity through people interaction and experiences. However, those voices remain few in comparison to the huge body of literature that adopts traditional conservation theories that reject imitations and consider them as 'fakes'. In fact, traditional conservation theories consider 'fakes' to deceive the public, stressing that any additions to historic buildings should be identifiable to avoid falsifying history (Jokilehto, 2013; Khalaf, 2018).

With the above conception of conservation, authenticity, traditional places, themed-places and fakes, many questions could be raised, such as: Should traditional places be authentic? Could ideas of 'real' and 'fake' be relative? Could fake places or imitations of traditional places still be considered 'traditional'? Could fake 'traditional' places produce authentic experiences? And could imitations of traditional places be a way to sustain interest in heritage?

The research Design: objectives, methodology and methods

This research studied the phenomenon of 'traditional' cafés in the Kingdom of Bahrain. Traditional cafés or what is known locally in the Kingdom of Bahrain as 'gahwas' were an essential part in the Bahraini culture. They used to be social places where men gathered any time of the day to discuss different matters over a cup of tea. Food was also served in those traditional cafés in a style of 'all day' menu. News, events and daily gossips were exchanged and discussed in those cafés. Also, commercial deals were sometimes closed there. Thus, in today's terms, traditional cafés served as public social places, cafes, restaurants, places where one could spend his leisure time and more.

In recent years, there has been a noticeable revival of the phenomenon of traditional cafés in Bahrain. Although, the contemporary 'traditional cafés' do not follow functionally the old model of 'gahwas', most of them attempt to resemble or at least relate to the 'old days' either through their interiors, furniture, menu, or even their names. The main aim of the research was to understand the language used to convey the idea of 'being traditional' by the owners of those cafés, and to evaluate how is it perceived by the users on the other end.

The research used case studies of authentic traditional café, and themed cafes that adapt traditional themes, whether in their name, architecture, interior, menu or other aspects. The choice of the case studies considered the history and authenticity of the cafés as well as the architectural expression. In this chapter, we are presenting two case studies with different settings; one authentic traditional café within a traditional setting, and another completely new café/restaurant within a shopping mall that adopts traditional theme and interior. The methods used for data collection in this research were field studies for documentation and interviews.

For each case study, the team investigated the following:

1. Location and site analysis – using maps and aerial photos. Site analysis was conducted to study the surroundings of the café (zoning, building's types, roads and traffic, heights, architectural language, etc.)
2. Documentation of the place and its history - This involved:
 - a. Collecting information about the history of the café and the building (historical records,

- newspaper, internet, oral history, etc. – as appropriate)
 - b. Exterior and interior photos showing different parts of the café
 - c. Collecting or producing measured drawings of the place
 - d. Detailed interior drawings
3. Pattern of use (opening hours and the busy and quite times throughout the day, age and gender of users, etc.) – through observation and interviews with workers
 4. Evidence collected from studying the menu and its development over time (e.g. how traditional or contemporary are the dishes offered? Are they all Bahraini dishes? Are they served all day or focus on certain meals? How do they relate to the idea of 'being traditional'? What changes have been done over time etc.)
 5. Owner/workers' views: Is the café considered traditional from the view of the owner/workers? And if it is, then what makes it so in their opinion?
 6. Users' views (around 20 responses): Is the café considered traditional from the view of the users? And if it is, then what makes it so in their opinion? What attracts people most to the café (food, atmosphere, memories of the past, being different, other reasons)?

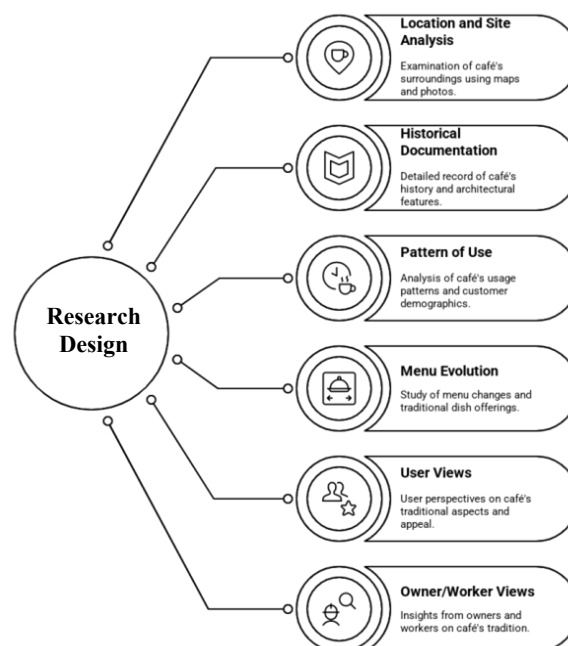


Figure 1: Research Design

Case Study 1: Haji Café – An Authentic Traditional Café

Located in the heart of Bahrain's capital city, Manama, Haji Cafe is one of the oldest traditional cafes, established in 1950 by Haji Ghulam Hussain. Its location near Bab Al-Bahrain, and proximity to one of the largest traditional souqs (markets) in the Kingdom, makes it a popular spot. Initially a modest space with a single door and three tables, the cafe quickly gained popularity among locals. Over the years, it evolved into one of the favourites 'qahwas' (cafés) for locals.



Figure 2: Historic photos and records of Haji Café.

For over seventy years, this cafe has been hidden in a narrow alley in the heart of Manama's traditional district. Its outdoor setting is featuring traditional tables and benches, serving as a visual testimony to its long-standing presence and offers a glimpse into the past. The alley and the cafe's exterior walls are decorated with a collection of vintage photographs and newspaper articles, each telling its own story and acting as a historical witness to the cafe's rich history. The area is usually very busy with locals and tourists alike, drawn to the vibrant market atmosphere. Surrounded by numerous offices, apartments, and hotels, Haji Cafe has become a popular destination for both residents and visitors. Such experience fosters both nostalgia and connection, allowing customers to enjoy the interplay of tradition, culture, and modern life.

The place with its setting, ambience, traditional interiors, furniture, and typical traditional cuisine attracts locals, residents and tourists of different nationalities and cultural backgrounds. In a today's global world, with social media being the leading and most popular tool, Haji Cafe's name became well known internationally. Because of the online reviews, many from around the world took the chance to visit it, which increased the popularity of the place and made Haji Cafe wins many awards.



Figure 3: Traditional Exterior of Haji Café.

The traditional simple interior design is especially seen in the treatment of the ceiling using old Bahraini houses as a design reference. The original wooden ceiling, made from palm trunks called 'danchel' is kept, and wall recesses are used decoratively. Additionally, the traditional 'bluish tone' tables and wooden benches are covered with fabric featuring typical patterns inspired by Bahraini heritage. Similar to the exterior, the walls display the old photographs that evoke memories from the past, creating the nostalgic atmosphere for visitors. Traditional Bahraini interiors are a blend of function, craftsmanship, and cultural symbolism. Wood is central to the design, with palm wood and reed being common materials for furniture and structural elements. Although, there are several traditional elements in the interior, the place reflects the simplicity of traditional Bahraini architecture without excessive use of decorative elements.



Figure 4: Traditional interior and food of Haji Café.

As previously mentioned, the original Haji Cafe was established in 1950 by Haji Ghulam Hussain. Over time, the place has been operated as a family business: first by his son and currently by two of his grandsons. Zuhair Haji explains: "Our father transformed the cafe from the traditional place to an iconic establishment in Bahrain; both locals and tourist gather here." He adds: "Haji Cafe is a home for everyone. Fresh traditional Bahraini food is prepared under the family supervision. The old generations are still gathering in the cafe and this is what keeps the tradition and history alive. The idea is to attract the young generations as well and teach them about our traditions".

Case Study 2: Ghancha Café – A Traditional-Themed Café

Ghancha Cafe is located in Al Aali Shopping Mall, in the heart of Seef District; a popular and dynamic area known for its shopping centers and commercial hubs. This location and proximity to other commercial establishments makes Ghancha Café easily accessible for both locals and tourists.

Generally, Seef area experiences moderate to heavy traffic, especially during evenings and weekends. This is due to the shopping malls and dining establishments within the area. Parking spaces are available in Al Aali Mall near the café which facilitates its accessibility. In terms of surroundings, most buildings within the immediate vicinity range are between 4-20 stories. Shopping malls are low-rise complexes compared to the residential and office towers surrounding them.

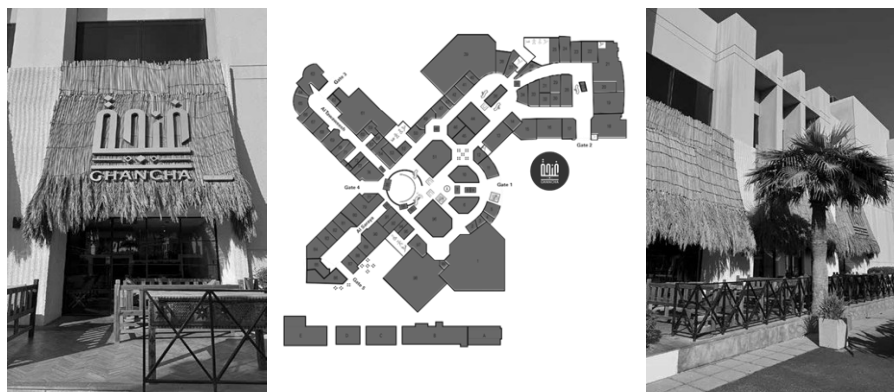


Figure 5: Location and exterior of Ghancha Café.

The architectural language of the area combines contemporary and modern architecture; characterized by glass facades and clean lines. Al Aali Mall, where Ghancha café is located, was opened in 1996. The architecture design of the mall gracefully combines the traditional style with contemporary architecture. In fact, Al Aali Mall features a section known as 'The Souq' where the whole section with its shops, cafes and restaurants are designed with traditional themed interiors and traditional architectural elements to enhance the atmosphere in this section. Gancha café, which was opened in 2023, is not located within The Souq area of Al Aali Mall. However, it was designed with a traditional Bahraini theme, making it a contrasting, but also attractive spot for both locals and tourists seeking such experience.

In terms of exterior façade treatment, natural palm leaves are used to shade the entrance and other opening on the façade creating visual identity of culture and traditional roots. Also, beige textured walls are used in the exterior façade to replicate (to a certain extent) the textured walls of traditional Bahraini houses. Similarly, wooden benches and tables with traditional patterned cushions are used for outdoor seating to support the traditional theme and enhance comfort, while palm trees and greenery are adding a touch of vibrancy and shade.

The interior and color palette of the café is characterized by earthy tones, natural textures, and traditional materials like woven fabrics and wood. Also, palm leaves are used for ceiling decoration which together with the textured walls emphasize the use of natural materials. The dining space of the café combines traditional Bahraini aesthetics with functional design to create a warm atmosphere. Similarly, the central counter area, combines Bahraini woodwork with modern design to facilitate functionality. For furniture, a mix of traditional and modern pieces are used, such as chairs with stitched details and wooden tables. Additionally, rustic shelves that act as a background for the seating area are presented with displays of Bahraini heritage items like traditional tea sets and cookware. Decorative elements also include woven baskets, pottery, and other heritage-inspired items. Generally, attention to details is noticeable in the engraved table patterns and handcrafted items. To complement the theme, waiters are also dressed in traditional Bahraini customs.



Figure 6: Traditional themed interior and food of Ghanca Café.

In addition to the exterior and interior traditional theme, Gancha café is presented as ‘traditional Bahraini café’ on their Instagram account. The café opens 7 days a week, from 7:00 am-10:00 pm (11:00 pm on weekends). The menu of Gancha cafe contains both local traditional and contemporary dishes. Traditional Bahraini dishes reflect the local character, while international dishes and drinks are also offered to suit different tastes, giving the cafe a modern touch. In fact, the modern touch is reflected in the menu design that is aimed at the modern audience and even in the presentation of traditional dishes making the restaurant a distinctive combination of traditional and contemporary cultures. Although the café is relatively new, the traditional theme is emphasized through the attention given to the design, interior details and menu.

Findings and Discussions

This section summarizes the case studies data collected from the field visits and the findings of the interviews and surveys conducted for this research. Table 1 below compares the findings of the two case studies:

Table 1: Summary of the case studies findings.

	Haji Café	Ghancha café/restaurant
Location	Bab Al-Bahrain area, in the heart of Manama City, a very busy and popular area of the capital city.	Al Aali Shopping Mall; a popular and dynamic area known for its shopping centers and commercial hubs.
History/ Authenticity	Opened in 1950.	Opened in 2023.
Exterior Façade	Exterior features are traditional furniture along with wooden shutters, carved wooden doors	Exterior features are natural palm leaves, beige textured walls wooden benches and tables

	and exposed beams. The narrow road (zarnooq) is shaded by traditional fabric.	with traditional patterned cushions, palm trees and greenery adding vibrancy and shade.
Interior	Ceiling features wooden construction using palm trunks known as 'danchel,' along with palm wood and reed, walls are decorated with old photographs, while arches and recesses serve as decorative wall treatments, tables in 'bluish tone' and wooden benches are enhanced with fabric showcasing traditional Bahraini patterns.	Café interior is characterized by earthy tones, natural textures, traditional materials, woven fabrics and wood, palm leaves for ceiling decoration. Bahraini woodwork is combined with modern design for the counter, traditional and modern furniture, stitched details, wooden tables, and display of traditional items. Also, staff are dressed in traditional Bahraini customs.
Operation hours	7 days a week, from 5:30 am - 09:00 pm (three timings specified for serving breakfast, lunch and dinner).	7 days a week, from 7:00 am - 10:00 pm (11:00 pm on weekends).
Menu	Mainly based on traditional cuisine, featuring typical dishes and drinks that are commonly cooked and served in Bahraini homes. Over time, some non-Bahraini dishes have been added to the menu for years and are now considered local by many.	The menu contains both local traditional and contemporary dishes, modern touch reflected in the menu design and presentation of traditional and more contemporary dishes.
Owner's/workers' view	• Popularity and simplicity: Simplicity is represented in all aspects of the café: - The Menu which includes traditional dishes and some others that were added over time to suit modern demands - The way the food is served (traditional plates used to serve food as each plate has a different color) • History and memory of the place • The traditional and historic architectural and decorative elements • Highlight the old times and identity of old Bahrain	• Architectural and interior design: The café's interior and exterior incorporate traditional Bahraini architectural features, such as the use of natural materials like palm fronds and earthy tones, which reflect the country's cultural heritage • Menu: emphasizes traditional Bahraini dishes and beverages, aiming to provide an authentic local dining experience • Cultural atmosphere: The atmosphere is enhanced by traditional music and décor, creating an environment that draws references to Bahrain's 1960s and 70s
Users view	Most users recognize the place as a traditional Bahraini café based on the following reasons: • The fact that it is located within the traditional fabric of Manama • Evoking memories of humble and simple life of old Bahrainis • Simplicity of the traditional exterior and interior features • Overall atmosphere • Affordable traditional food	Most users recognize the place as a traditional Bahraini café based on the following reasons: • The name reference (Ghancha is a traditional plate) • Cultural Connection and overall design with traditional references (decorative accessories, traditional patterns, staff uniform) • Food serving traditional dishes with a modern twist • Memories triggered by the atmosphere and details where some are drawn to the nostalgia of the past

From the interviews with the owners and workers of both case studies, both cafes are viewed as traditional cafes by their owners and worker, however for different reasons. In Haji café, owners and staff perceive the place as traditional because of its history and memory, popularity and simplicity, especially in terms of food and presentation. Although mentioned, less emphasis was placed on architecture and interior features. On the contrary, in the case of Ghancha café, architecture and interior features were mentioned first, supported by the menu offerings and general cultural atmosphere like accessories and music.

Regarding users' view, the qualitative analysis of the conducted interviews revealed again, that regardless of the historic gap between Haji café; the authentic traditional café and Ghancha café, the newly established traditional-themed café, both establishments are perceived as traditional by their visitors. In the case of haji café, emphasis was placed on the historic context and the reflection of the old days' simple life, traditional food with affordable prices. In the case of Ghancha café, users' emphasis was placed on the name, design, decorative elements and food.

Accordingly, it is noticeable that regardless of the gap in historic and material authenticity between the two cafes, both seem to produce authentic experiences in different ways according to their users that fulfill their expectation of traditional places.

Conclusion

Based on the findings, the research concludes that the conception of authenticity differs between heritage experts and lay people. While the dominant understanding of authenticity within the academic and professional field emphasises the physical aspect of authenticity, lay people place more emphasis on the spatial, emotional and intangible experiences.

This chapter tries to shed light on the positive side of architectural imitations and to view them as more empathetic and thoughtful attempts to appreciate traditional architecture by lay people. When it comes to users/visitors, imitations could be viewed as a means for sustaining interest in cultural heritage, especially for young and future generations who do not necessarily have references of the past. On the other hand, in terms of experiences, as presented in this chapter, imitations of traditional places/ traditional-themed places seem to produce authentic experiences according to their users. Finally, imitations of traditional architecture and interiors could be acknowledged as a means of documentation that makes heritage more accessible.

Acknowledgement

The authors would like to acknowledge the valuable contributions of the Architecture students of Vernacular Architecture course, Department of Architecture and Interior Design, University of Bahrain (Academic year 2024/2025) who participated in this research. Their efforts and engagement were instrumental to the development of this study.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 7

The “Parco dei Tratturi della Puglia”: *A Historical-Cultural Heritage between Migrations and Landscape*

* Dr. Giorgia Coviello

Introduction

The ecological and cultural importance of the rete tratturale in Puglia

The interaction between man and the environment has given rise, over the centuries, to multiple forms of landscape that are the result of a delicate and constant balance between human needs and natural dynamics. A significant example of this interaction is the *rete tratturale* (tracturale network) of Puglia, a road system that has its roots in the ancient practice of *transumanza* (transhumance). *Transumanza*, which has profoundly characterized the economy and culture of local communities for centuries, has contributed to creating a unique and unrepeatable agro-pastoral landscape, in which natural elements blend harmoniously with anthropic ones, giving rise to a landscape configuration that is as peculiar as it is functional.

The *rete tratturale* of Puglia is distinguished not only by the natural characteristics that compose it, such as *ampi pascoli* (large pastures), *boschi* (woods), *garighe* (garrigues) and *macchia mediterranea* (mediterranean scrub), but also by the presence of traditional structures made by man, such as *muretti a secco* (dry stone walls) and *jazzi* (dry stone fences for sheep), used to shelter livestock during long seasonal movements. This semi-natural landscape reflects a dynamic balance, maintained over time thanks to pastoral activity, which has prevented shrub recolonization phenomena and has favored the conservation of open habitats of great ecological value. Grazing activity, particularly that linked to sheep farming, has proven to be fundamental for the creation and maintenance of a variety of microhabitats that favor the presence of specialized plant and animal species in transitional environments between more wooded areas and open grasslands. The biodiversity that characterizes these environments is the result of a sustainable balance between man and nature, which has allowed the survival of numerous ecosystems with high biological richness.

Throughout history, the *rete tratturale* has played a fundamental role not only from an economic and social point of view but also as a crucial element for the ecological connection between different areas of the territory. The *tratturi* (sheep tracks) can be considered true ecological corridors, which allow the continuity of natural habitats and favor the mobility of wild fauna. In the context of increasing fragmentation of natural habitats, mainly due to the expansion of urbanized areas and the intensification of agricultural practices, the *tratturi* represents one of the last links between fragmented ecosystems, allowing animal species to move freely between areas of great ecological value. This aspect takes on particular importance in areas with a strong anthropic impact, where the *tratturi* can become the only connection routes between otherwise isolated habitats, allowing not only the movement of migratory species but also the dispersion of seeds of native plants that are essential for the maintenance of plant diversity.

In addition to their ecological value, the *tratturi* represent a cultural heritage of immense value. These historical routes are the result of centuries of interaction between man and the environment and embody traditions, knowledge, and practices that have marked the life of the pastoral communities of Puglia. Their protection, therefore, is not only concerned with environmental protection but is also linked to the conservation of a historical legacy that tells the identity and cultural evolution of the Puglia region. The *tratturi* are not only transit routes but true witnesses of *transumanza*, an activity that has had a profound impact on the social, economic, and cultural organization of local populations. In a world that is rapidly changing, the protection and enhancement of these historical routes also represent a strategy to strengthen the connection between past and future generations, keeping alive an indissoluble bond with the territory.

In the current context, characterized by accelerated anthropization and profound changes in agricultural practices and the rural landscape, the recovery and enhancement of the Apulian *rete tratturale* are becoming increasingly important. These historical routes not only contribute to the conservation of unique landscapes but can also become strategic tools to

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How to Cite This Chapter:

Coviello, G. (2025). The “Parco dei Tratturi della Puglia”: A historical-cultural heritage between migrations and landscape. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 54–60). Cinius Yayınları. <https://doi.org/10.38027/N7ICCAUA2025EN0054>

promote sustainable development models, which respect historical memory and promote the recovery of ancient traditions. The redevelopment of the *rete tratturale*, with its dual ecological and cultural function, can stimulate the creation of new tourist routes that combine nature and culture and represent an opportunity for local communities to relaunch the rural economy through sustainable tourism. In this way, the *tratturi* can become key elements not only for the conservation of biodiversity and the rural landscape but also to promote a territorial regeneration that puts the relationship between man and nature at the center. Their valorization, therefore, is not only a question of ecological protection but also an opportunity to promote tourism, culture, and the history of the territory, contributing to the creation of a development model that is truly sustainable and capable of preserving the historical memory of local communities.

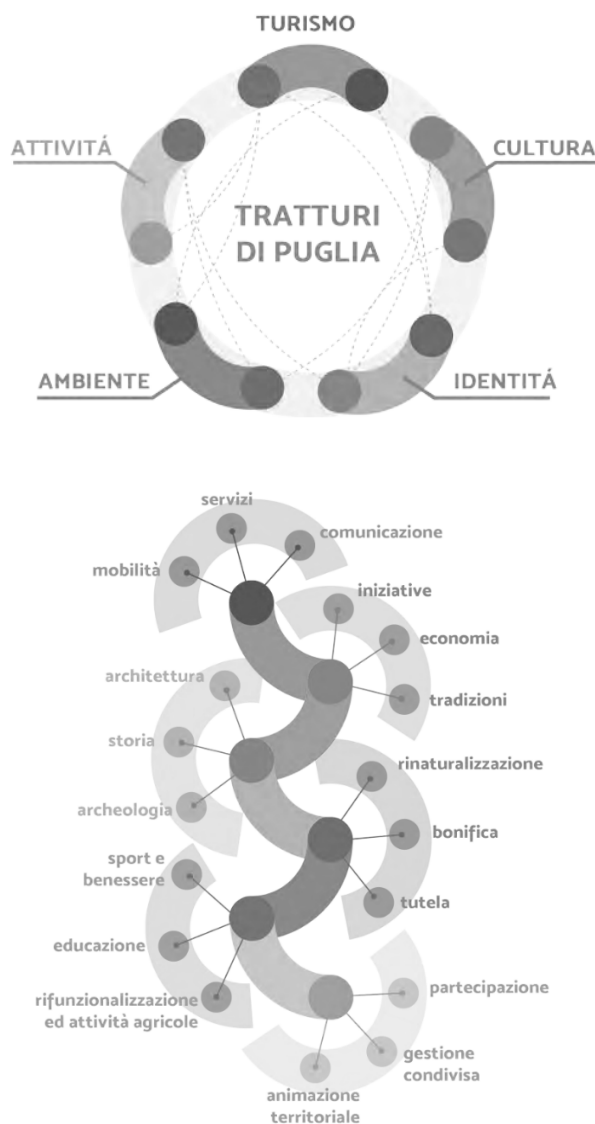


Figure 1. Structure of the Study (Developed by *Documento Regionale di Valorizzazione dei Tratturi di Puglia*).

Statement of the problem and gap

The historical evolution of the *rete tratturale* in Puglia has undergone profound and significant changes over the centuries, transforming its function and perception within the territory. Originally conceived as a fundamental infrastructural system to support *transumanza*, this network has played a crucial role in connecting the different mountain and plain areas, allowing the seasonal movement of livestock. However, over time, due to the change in pastoral and agricultural practices, the function of the *tratturi* has been progressively scaled down and, in many cases, abandoned. The progressive decline of traditional *transumanza* has caused a reduction of the vast areas dedicated to grazing, which were once essential for the sustenance of pastoral communities. This has resulted in the gradual isolation and fragmentation of the *rete tratturale*, compromising its ecological continuity and reducing its functionality as a natural corridor for local fauna.

If once the *tratturi* were fundamental as communication routes for *transumanza*, today they mostly represent elements of a residual landscape, often not recognized for their ecological and historical value. This change has generated a significant gap in land management, which has manifested itself in a loss of traditional maintenance practices and a progressive loss of identity of the *paesaggio tratturale* (tractural landscape). The lack of an adequate conservation strategy could lead to the deterioration of these ecological corridors, which are fundamental not only for local biodiversity but also for the conservation of the historical and cultural landscape that characterizes them. If not addressed promptly, the risk of further degradation of the *rete tratturale* could compromise the ability of these routes to perform crucial ecological functions, such as maintaining biodiversity and resistance to the effects of climate change.

At the same time, we are witnessing a progressive erosion of traditional knowledge related to the management of pastures and agricultural practices related to *transumanza*. Pastoral communities, which for centuries have maintained a delicate balance between man and the environment, are facing an evident decline, which involves the loss of skills and agricultural practices related to the care and enhancement of the territory. The progressive abandonment of traditional landscape management techniques, combined with the spread of intensive agricultural practices, further threatens the conservation of the *rete tratturale*, compromising the possibility of functional recovery of the *tratturi* and their ability to generate ecological, economic, and cultural benefits.

This scenario raises a crucial and urgent question: how to ensure the conservation of the Apulian *rete tratturale* while respecting its historical, cultural, and environmental value? The lack of an integrated protection and enhancement strategy represents a significant gap that risks irreparably compromising the future of these historical routes, as well as the possibility of preserving the identity and rural landscape of Puglia. If timely intervention is not done, the risk is that the *tratturi*, one of the most representative elements of the history and culture of Puglia, may progressively disappear, with a negative impact not only on the cultural heritage but also on biodiversity and the rural landscape. Addressing this gap means promoting an integrated recovery and management strategy that considers the ecological, historical, and social dimensions of the *tratturi*. This strategy could be the key to ensuring the survival of one of the most significant elements of the natural and cultural heritage of the region, also offering new opportunities for local communities through the enhancement of the territory and the promotion of sustainable agricultural and pastoral practices.

Objectives and Hypotheses

The main objective of this study is to analyze in depth the fundamental role that the Apulian *rete tratturale* plays in the conservation of biodiversity and the ecological connection of the territory. In particular, it intends to identify and propose effective strategies for the protection and enhancement of these historical routes, which are of great importance from both an ecological and cultural point of view. The basic hypothesis on which this research is based is that a targeted intervention for the recovery and management of the *rete tratturale* can have a significant and positive impact in improving ecological connectivity, contributing to the preservation of the historical landscape and the development of management models that are both sustainable and respectful of local traditions.

A further objective of the research is to explore and enhance the potential of the *rete tratturale* as a cultural and socio-economic resource. In this context, it is planned to examine the possibilities of integrating the *tratturi* with sustainable tourism through the creation of ecological tourist itineraries, but also with traditional agro-pastoral practices that are historically linked to these routes. The recovery of the *tratturi* could encourage the creation of hiking and cycling routes, stimulating the development of tourist activities focused on ecotourism, which allows visitors to discover the history, culture, and natural beauty of these territories. This process could not only favor the growth of tourism but also promote an enhancement of local traditions, strengthening the link between communities and their cultural heritage.

Furthermore, the redevelopment of the *rete tratturale* could represent a significant opportunity for rural communities, helping to generate new forms of income linked to the sustainable management of the territory. Such redevelopment, if well planned, could stimulate the local economy, creating new employment opportunities and supporting the growth of small and medium-sized enterprises operating in the tourism, sustainable agriculture, and services sectors. Enhancement policies could, therefore, act as a driving force for a new economic development model that can combine economic growth with the protection of natural and cultural heritage.

Finally, the research aims to identify and propose innovative strategies that can make the *rete tratturale* an integral part of territorial planning policies, ensuring its resilience in the long term. A central aspect will be achieving a balance between environmental conservation, necessary to protect biodiversity and preserve historical landscapes, and the socio-economic development of rural areas crossed by *tratturi*. In this framework, management policies will have to be developed in such a way as to support not only environmental protection but also the economic growth of local communities, avoiding depopulation phenomena and ensuring balanced and sustainable development. In this way, it will be possible to contribute to the creation of an integrated management model that fully enhances the *patrimonio tratturale* (tracturale heritage), making it a key element for the sustainable development of Puglia.

Materials and Methods: Valorization of the *Tratturi* of Puglia

The present work aims to analyze the criteria and guidelines necessary for the protection and valorization of the *rete tratturale* of Puglia to protect the natural, historical, and cultural values of these historical routes while promoting compatible economic activities, such as sustainable tourism, culture, and recreational activities. The valorization of these itineraries has as its ultimate goal the improvement of the quality of life of local communities, within the *Parco dei Tratturi*. The guidelines developed for the valorization of the *tratturi* consider the territorial specificities, with particular attention to the ecological, historical, archaeological, and cultural characteristics of each section of the *rete dei tratturi*, to ensure a respectful and targeted intervention.

The *rete tratturale* that crosses Southern Italy, with particular emphasis on Puglia, represents a strategic resource for the development of the territories crossed. The enhancement of this network focuses on key aspects such as the ecological function of the *tratturi*, their integration into the regional road network, the promotion of sustainable tourism practices, and the enhancement of the historical memory linked to *transumanza*, which has been one of the most significant traditions of the region for centuries. Another fundamental aspect concerns the inclusion of state-owned properties in sustainable agricultural practice projects to promote the economic development of rural areas without compromising the environment and natural resources. The planned interventions are divided into physical and intangible actions to improve the perception, accessibility, and usability of the *rete tratturale* and the surrounding areas. Furthermore, the aim is to promote knowledge of the *tratturi* and their historical, cultural, and environmental values through awareness-raising and education projects. The guidelines for the enhancement of the *tratturi* are divided into various thematic areas, each of which responds to specific needs and objectives to create a cohesive and sustainable network of interventions. In particular, the main areas of intervention concern mobility, vegetation and ecology, cultural identity, multifunctionality of the areas, and signage, as detailed below.

Guidelines for the enhancement of *tratturi*:

The interventions outlined in the guidelines are divided into different thematic areas that respond to specific needs and objectives, aimed at ensuring a balanced and sustainable enhancement of *tratturi*. In particular, the main areas of intervention concern the following aspects:

1. Mobility
 - Study of tourist potential: An in-depth analysis of *percorsi tratturali* (tracturale routes), considering their landscape attractiveness, ease of access, and safety. The length of the routes and the possibility of creating multi-stage itineraries that can attract tourists and visitors, offering different experiences, will be considered.
 - Adaptation of existing roads: Design of solutions for soft mobility along the *rete tratturale*, avoiding the construction of new infrastructures, such as cycle paths, which could alter the natural landscape. The idea is to preserve the environment and optimize existing infrastructures.
 - Multimodal accessibility: Creation of connections with train stations, bus stops, and other mobility facilities to ensure universal accessibility and usability of the *aree tratturali* (tracturale areas) by all types of users, including people with disabilities.
2. Vegetation and Ecology
 - Protection of historical landscapes: Renaturalization and redevelopment interventions of degraded areas, with the creation of ecological networks that connect areas of naturalistic interest and improve biodiversity along the *tratturi*.
 - Identification of sustainable agricultural practices: Promotion of crops that respect the environment through the choice of symbolic and ecological plant species closely linked to the *paesaggio tratturale* and the agricultural tradition of the region.
 - Improvement of environmental quality: Strengthening of vegetation along the *tratturi*, improving the landscape, and creating a more favorable environment for use on foot or by bicycle, promoting eco-friendly tourism.
3. Cultural Identity
 - Recovery of historical elements: Protection and enhancement of the identifying elements of the *paesaggio tratturale*, such as *cippi lapidei* (stone markers), *jazzi* (dry stone fences for sheep), *chiesette* (small churches) and *fontane* (fountains), which testify to the historicity of *transumanza* and the life of shepherds along these routes.
 - Creation of cultural spaces: Transformation of existing structures into spaces dedicated to the memory of *transumanza* and the history of *tratturi*, where visitors can deepen their knowledge of the historical and cultural heritage linked to the tradition of pastoralism.
4. Equipped Areas and Multifunctionality

- Creation of rest areas: Creation of equipped areas along the *rete tratturale*, near points of landscape or historical interest, which encourage visitors to rest and stop, improving the tourist experience and ensuring comfortable and safe use.
 - Recovery of existing structures: Reuse of public or private buildings for compatible economic activities, such as *masserie* (farms) and *aziende agricole* (agricultural businesses), to stimulate territorial development and integration with the landscape, promoting the creation of local businesses linked to agricultural production and tourism promotion.
5. Signage and Recognisability
- Unified visual identity: Creation of clear and unified signage for all the *tratturi* in Puglia, which allows visitors to easily orient themselves along the routes, using interactive devices such as QR codes to facilitate the digital use of historical and cultural content, improving access to information and the overall experience.
 - Wayfinding and accessibility: Installation of signage to ensure the continuity of the route, inform visitors about points of interest, and raise awareness among motorists about the presence of the *tratturi* so that they can respect the traffic and contribute to everyone's safety.

To develop a valorization strategy for the Apulian *rete tratturale*, this study will use a multidisciplinary approach, which will include the collection and analysis of historical, ecological, and socio-economic data. In-depth studies will be conducted on the geography and history of the main Apulian *tratturi*, with particular attention to the *Regio Tratturo Pescasseroli-Candela*, an emblematic example of a *percorso tratturale* that crosses several areas of great ecological and cultural value.

In particular, the analysis of the *Tratturo Pescasseroli-Candela* will focus on the study of its ecological characteristics, its history, and its role in the Apulian landscape. The opportunities for recovery and valorization of this stretch will be explored, with particular attention to the tourist potential and the possibilities for environmental recovery. Furthermore, the actions envisaged by the *Piano Operativo Integrato del PTCP di Foggia* (Integrated Operational Plan of the PTCP of Foggia) will be taken into consideration, which plan aims to promote the recovery and enhancement of the *Tratturo Pescasseroli-Candela* as part of an integrated territorial development project that considers the ecological, historical, cultural, and socio-economic needs of the territory.

Discussion: The future of the Apulian *tratturi*

The enhancement of the Apulian *rete tratturale* represents a significant and complex challenge, which involves the difficult task of finding a balance between the conservation of the ecological, cultural, and landscape aspects of the *tratturi* and the socio-economic development of rural areas. The *tratturi* are not simple transit routes but authentic witnesses of the history, culture, and traditions of the region. Their preservation is crucial not only to protect the historical heritage but also to guarantee the biodiversity and health of the surrounding environment, which is strongly linked to the management and use of these ancient routes.

A key element for the success of a project to enhance the *tratturi* is the active involvement of local communities, farmers, and breeders, who have traditionally lived and worked along these routes. Only with their direct participation will it be possible to guarantee sustainable management that allows agricultural and pastoral activities to continue without compromising the ecological integrity of the territory. It is essential that agricultural and pastoral traditions, which have been part of the daily life of Apulian communities for centuries, can be maintained over time, promoting environmentally friendly and sustainable agricultural practices to preserve the unique characteristics of these places. In this context, the enhancement of the *tratturi* cannot be limited to their recovery as simple tourist routes. It must be an integral part of a territorial development project that includes the creation of broader tourist itineraries capable of connecting the *tratturi* to other cultural, historical, and natural routes present in Puglia. The construction of a network of itineraries that connects these routes would strengthen the visibility and attractiveness of the *tratturi*, contributing to the economic revival of rural areas. This development should also stimulate slow and sustainable tourism, which enhances the territory and traditions without altering its identity and ecological fragility. This process must be planned in such a way as not to damage the landscape and local biodiversity but rather promote their protection, while at the same time allowing a conscious and respectful use of natural and cultural resources. However, the creation of a tourist network that includes the *tratturi* must be approached with great attention to sustainability. The pressure of tourism, if not managed carefully, could lead to a deterioration of the landscape, the loss of biodiversity, and the risk of damaging the most sensitive areas of the territory. A balanced approach to the enhancement of the *tratturi* therefore requires integrating ecological conservation with development needs, creating solutions that allow the enjoyment of the *patrimonio tratturale* without compromising its historical and natural value. In conclusion, the protection and enhancement of the Apulian *tratturi* are essential not only for the conservation of the historical and cultural memory of the region but also to

promote a territorial development model that is sustainable and respectful of the environment. The *rete tratturale* is a heritage that must be carefully cared for, integrating tradition with innovation, and must be seen as an opportunity to generate a positive and lasting impact on local communities. The enhancement of the *tratturi*, if managed correctly, can represent a key to the future of the rural areas of Puglia, promoting a new economic development that respects the regional identity, biodiversity, and landscape.

Conclusion

The *rete tratturale*, with its inestimable historical and landscape value, represents a fundamental resource for local communities, which can exploit an ancient tradition as a driver of development and sustainable growth. The proposed guidelines, which constitute a reference framework for the design and implementation of interventions, are essential to guide actions and ensure their effectiveness. An approach that, in addition to considering the environmental and historical aspects, places particular emphasis on sustainability and inclusiveness, ensuring that the benefits deriving from the enhancement of *tratturi* can be distributed equally among all the subjects involved, including the inhabitants and economic actors of rural areas.

In this context, the synergy between soft mobility, environmental redevelopment, and cultural enhancement emerges as an integrated and innovative strategy, capable of promoting the conscious use of the *patrimonio tratturale*. This approach not only promotes a responsible recovery of these resources but also stimulates tourist growth that respects the environment and local culture. The active involvement of local communities, farmers, breeders, and tourism operators is crucial since the enhancement of these routes requires a network of collaborations that recognizes the importance of a balanced, responsible, and long-lasting territorial development model. In this vision, the *patrimonio tratturale* becomes a factor of social cohesion and renewal, not only on an economic level but also on a cultural level, thanks to its ability to stimulate a sense of belonging and pride among local populations. The protection and enhancement of the *rete tratturale* of Puglia are of fundamental importance, not only for the preservation of biodiversity and characteristic landscapes but also for the maintenance of the cultural identity of a region that has been intrinsically linked to these traditions for centuries. The interventions proposed in this study, through integrated and sustainable management of the *rete tratturale*, represent a strategic resource for the socio-economic revitalization of rural areas of Puglia. The proposals aim to promote the creation of new economic opportunities without compromising the ecological integrity of the territory, ensuring a balance between the needs of development and the protection of natural and cultural heritage.

The redevelopment of the *rete tratturale*, combined with the creation of sustainable tourist itineraries and the promotion of environmentally friendly agricultural practices, can give rise to a renewed relationship between man and nature, with positive effects on the quality of life of local communities. This territorial development model, focused on sustainability, can strengthen the resilience of local ecosystems, countering the loss of biodiversity, and promoting the adoption of responsible and conscious behavior by new generations. The creation of tourist itineraries, together with awareness-raising and environmental education initiatives, will promote not only knowledge and enhancement of the *patrimonio tratturale* but also respect for the environment and for the traditions that have always distinguished this extraordinary landscape.

Ultimately, the enhancement of the Apulian *rete tratturale* does not only represent an economic opportunity for the region but also an important step towards building a future in which the protection of natural and cultural heritage goes hand in hand with a sustainable and inclusive development model, capable of responding to the challenges of the present and the future. The recovery and redevelopment actions of the *tratturi* are, therefore, the foundation of a development vision that not only respects historical memory and local traditions but at the same time promotes innovation, collaboration, and collective commitment to a better future.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 8

The Concept of the Garden City on a Micro Scale: A Case Study of the Urban Planning of Johow Gelände in Poznań and It's Challenging Heritage

Marianna Isańska, Dominika Plata, Kamila Kłudkiewicz

Poznań's Johow-Gelände: Adaptive Urbanism across Regimes

Urban space is far more than a neutral backdrop for human activity—it is a complex, dynamic arena where diverse forces converge and contend. Political, ideological, and cultural agendas are materialized in the built environment, rendering space a site of power struggles, but also of everyday negotiation and lived experience. Urban planning is not solely a matter of functionality or aesthetics; it also involves encoding certain visions of social order into the material form of the city. In this context, the district of Johow-Gelände in Poznań serves as a compelling example of how space may be employed both practically and symbolically, and how it reflects broader historical currents (Poznań, a city located in western Poland, is one of the oldest cities in the country and has a complex history shaped by Polish and German influences, particularly in the 19th and 20th centuries. In the period of the partitions of Poland, Poznań was part of Prussia and later Germany, only returning to Poland after World War I, and then again being part of Germany during WWII before becoming a part of Poland once more after 1945).

Founded in the late 19th century, Johow-Gelände was designed as a prestigious residential enclave for the urban elite, promoting the ideals of modernity, order and German national identity. The architectural diversity and formal coherence of the neighborhood - designed mainly by Max Johow - expressed not only urban rationalism, but also German cultural dominance over Polish. However, the fate of Johow-Gelände did not remain static. Following World War II and the establishment of the Polish People's Republic, the district underwent profound transformation. The original ownership structures were dismantled through processes of nationalization and municipalization, and the once-spacious apartments were subdivided into communal flats to accommodate the needs of a rapidly urbanizing, working-class population. This spatial fragmentation reflected the ideological shift toward collectivism and social equalization under socialism. The material degradation that followed was not merely a consequence of poor maintenance, but also a result of the state's ideologically driven housing policies. In the post-socialist period, new challenges and opportunities have emerged. Contemporary revitalization efforts aim to restore architectural heritage, but also grapple with the complex legacies of ownership, identity, and memory embedded in the space. The district's long history reveals how urban space is repeatedly reshaped by shifting political regimes, each leaving lasting marks on its form and function.

The central thesis of this research posits that the transformation of Johow-Gelände cannot be understood solely in terms of urban design; rather, it represents a symbolic enactment of ideological projects—from imperial power, through socialist collectivism, to neoliberal urban policy. Thus, the district becomes a microcosm of the political history of Central and Eastern Europe, a space where urban form and political intention are inextricably intertwined.

Methodological Framework and Periodization of Urban-Political Transformations

To fully grasp the complexity of Johow-Gelände's evolution, this research adopts a historical-urban methodology (Barłóg, 1989; Crowley, 1994; Grzeszczuk-Brendel, 2018; Howard, 2015; Juskiewicz, 2023; Kodym-Kozaczko, 2009; Skuratowicz, 1991), combining the analysis of urban planning documents (Plans of the housing estate preserved in the National Archives in Poznań, Akta Miasta Poznania (File of the City of Poznań) sig. 7316., documentation of the housing estate preserved Municipal Heritage Conservator's Office in Poznań, heritage records

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How to Cite This Chapter:

Isańska, M., Plata, D., & Kłudkiewicz, K. (2025). The concept of the garden city on a micro scale: A case study of the urban planning of Johow Gelände in Poznań and its challenging heritage. In Rokhsaneh Rahbariyanzad & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 61–69). Cinius Yayınları. <https://doi.org/10.38027/N8ICCAUA2025EN0103>

(conservation cards) of tenement houses located at 50–61 Matejki Street and 1–16 Grottgera Street), architectural transformations, and socio-political contextualization (Interviews conducted by Marianna Isańska and Dominika Plata with three residents of Johow-Gelände between February and April 2025 as part of this research indicate a substantial socio-demographic shift in the population inhabiting the area after World War II. Respondents were asked a set of questions regarding their experiences and perceptions, including when they moved into the area and whether they have lived there continuously since.



Fig. 1. Poznań, botanical garden in the so-called Johowa district. In the background are buildings in Matejki Street, circa 1910. Postcard from the beginning of the 20th century (source: University Library in Poznań).

They were also asked about their changing perceptions of green spaces over time, particularly in comparison to the 1980s and 1990s, the current structure of the population in terms of professions and social types, their thoughts on PRL-era architecture as reflected in photographs of the area, and the size and division of their apartments). The structure of the work is organized around three key phases in the history of Johow-Gelände. The first covers the formation of the district under Prussian rule (1890s–1918), when the estate emerged as a manifestation of German imperial ambitions and a model of bourgeois urban design (The period between 1918 and 1939, corresponding to the interwar years of the Second Polish Republic (II RP), is deliberately omitted. During this time, the district underwent significant political and administrative changes, including shifts in urban policy and priorities that do not align with the themes of imperial and socialist transformation explored in this text. Additionally, the socioeconomic and architectural changes of this period were overshadowed by the broader geopolitical and economic context, which complicates a direct analysis within the scope of this study.”). The second phase focuses on the transformations during the Polish People’s Republic (1945–1989), marked by nationalization, fragmentation of private apartments, and the ideological repurposing of space in line with socialist housing policy (The aim of this article is to analyze changes in the architecture and spatial layout of the housing estate; since no significant transformations occurred between 1918 and 1945, this period is omitted from the discussion). The final phase explores post-1989 revitalization efforts, with a focus on heritage preservation, reprivatization, and the socio-economic tensions arising from neoliberal urban development. Through the analysis of these three moments, the study aims to illuminate both the local urban history of Poznań and to derive broader conclusions about the ways in which urban space is transformed, utilized, and ideologically appropriated by different political regimes. This research contributes to critical urban studies by highlighting the political dimension of spatial planning, the long-term consequences of ownership transitions, and the contemporary challenges of heritage management within the socio-economic framework of late capitalism.

Urban Planning as a Tool of Ideological Transformation: A Century of Change in Johow-Gelände

After the incorporation of the Grand Duchy of Poznań into the German Empire in 1871, the city experienced a rapid influx of population. In order to overcome Poznań's status as a peripheral city and to retain the newly arrived residents of the Reich, it became necessary to develop a robust cultural and social infrastructure that would offer attractive living conditions (The Prussian authorities, particularly after the unification of Germany in 1871, undertook intensive Germanization efforts in Poznań, aiming to strengthen the city's German character in a region marked by a strong Polish identity. Despite significant investments in infrastructure and urban development, Poznań was perceived by many Germans as provincial and unattractive for permanent settlement.). One of the main obstacles to the city's expansion was the building restrictions imposed by its military fortifications from the first half of the 19th century, which led to overpopulation, a reduction in green spaces, and a significant deterioration in living standards (Skuratowicz, 1991, p. 131-160). These restrictions were further compounded by regulations regarding the use of military zones, such as the "safety zones" around the forts, which could not be built on due to the risk of artillery fire. These regulations were established under Prussian laws in the 1870s, when Poznań was transformed into Festung Posen (Fortress Poznań), restricting the city's growth and leading to overpopulation, a reduction in green spaces, and a significant deterioration in living standards. To expand the urban area, city planners in the 1890s initiated a project to incorporate the surrounding districts of Łazarz, Wilda, and Jeżyce. These plans also included the dismantling of the fortification walls, which proved to be a crucial step toward the modernization of Poznań (Skuratowicz, 1991, p. 111-117).

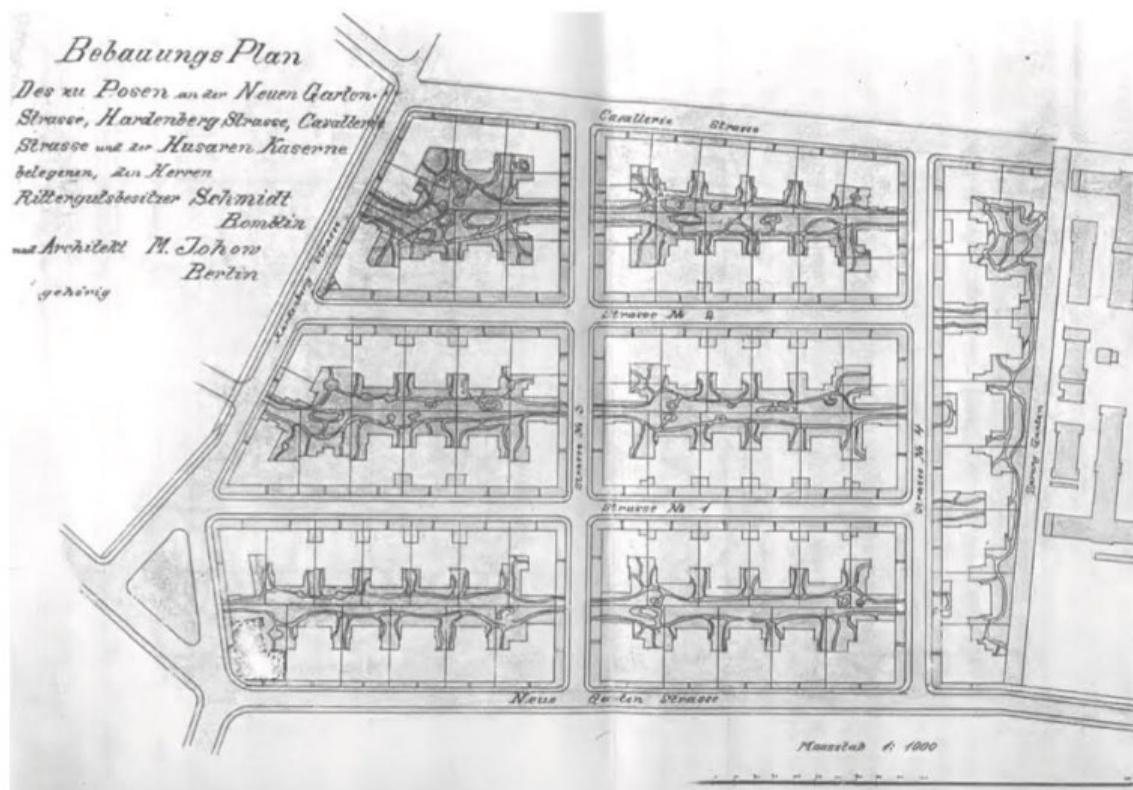


Fig. 2. Max Johow, construction projects of the district with gardens inside the quarters, front gardens and a reformist design of tenement houses, 1902 (source:

The urban planning strategy associated with the expansion project envisioned the construction of a modern infrastructure and the presentation of Poznań as a model Prussian city. This vision materialized in the redesign of the city center and the development of the so-called Imperial District (Kaiser-Viertel), whose central architectural landmark was the Imperial Castle (Zamek Cesarski), built on the orders of Emperor Wilhelm II. This new district was intended to serve both as the representational core of German Poznań and as a symbol of the German Empire's dominance over the Greater Poland region. The main architect of this ambitious transformation was Josef Stübben, one of the most prominent urban planners of his time, responsible for the modernization plans of numerous German cities. His redesign of the city center involved the redevelopment of areas previously occupied by military fortifications and the spatial integration of the historic core with the newly incorporated suburbs. Amid the broader context of urban modernization, Johow-Gelände emerged as a modern and luxurious residential district designed for the wealthiest and most prominent inhabitants of Poznań (fig. 1). As stated in governmental planning assumptions, "the urban composition was intended to serve as a framework for architecture with a programmatic, Germanising ideological agenda, and to illustrate the high quality of German urban culture. The construction activities following the defortification of the city further intensified the national polarization within Poznań's society." (The national polarization in Poznań at the beginning of the 20th century referred to the growing conflict between the Polish and German populations, driven by intensified Germanization policies implemented by the Prussian state. In response to the threat to their cultural identity, the Polish community began to develop its own institutions—such as schools, banks, cooperatives, associations, and press—creating a closely knit national environment. As a result, a clear socio-political and ethnic division emerged within the city, leading to the parallel existence of two distinct communities: Polish and German., orig.: "kompozycja urbanistyczna miała tworzyć ramy dla architektury o germanizacyjnym programie ideowym, ilustrować wysoką jakość niemieckiej kultury urbanistycznej. Działalność budowlana w ramach rozbudowy poznań po defortyfikacji wzmocniła narodowościową polaryzację społeczeństwa miasta". (Kodym-Kozaczko, 2009, p. 437.) Address books suggest that the majority of residents were German officials and military personnel; however, Polish surnames also appear in these records. It is important to note, though, that national identity is a highly complex issue and cannot be determined solely based on the sound of a surname, even if state policies at the time clearly favored German settlement (Barłóg, 1989, p. 61-63). The architect responsible for the urban planning of the estate, and the owner of most of its land, was Max Johow. The area was divided into seven building blocks (fig. 2), intersected by streets running parallel to today's Matejki Street (then Neue Gartenstrasse): Chełmońskiego (Helmholtzstrasse) and Kossaka (Schlütterstrasse), as well as by the perpendicular streets: Wyspiańskiego (Linnèstrasse), Grottgera (Liebigstrasse), and Siemiradzkiego (Hardenbergstrasse). The plots located along Matejki Street bordered the Botanical Garden (today's Wilson Park).

A true innovation in Johow's design was the elimination of rear wings (officines), which allowed for the replacement of traditional inner courtyards with landscaped gardens featuring winding paths. The apartment buildings, set back slightly from the street and preceded by small front gardens, formed a cohesive building frontage. Each façade was designed in a distinct aesthetic mode, drawing from historicist and Art Nouveau (Jugendstil) traditions. While individual façades were designed by various architects, the overall building mass and spatial arrangement were required to conform to Johow's master plan (Barłóg, 1989, p. 38). On the courtyard side, the articulation of the façades was diversified through risalits that were offset relative to the adjacent buildings, improving air circulation and natural light access. This spatial configuration exemplified innovative thinking in early 20th-century urban residential Johow-Gelände; garden layouts were carefully designed to blend seamlessly with the architecture, both at the front and courtyard sides. Beyond providing luxurious recreational space, the development incorporated a range of modern solutions aimed at meeting the highest sanitary standards. Only residential buildings were permitted within the estate, and strict construction regulations precisely defined the appearance and structure of the development, in accordance with Johow's master plan (Barłóg, 1989, p. 47). These rules governed the layout of each plot, the residential program, and the architectural form of the tenement houses. Each building was required to have four storeys (a ground floor and three upper floors) and a basement (Barłóg, 1989, p. 26-34). Only one third of the attic space could be used for residential purposes. Each floor contained seven- or eight-room apartments, with a drawing room at the front, bedrooms and a bathroom at the rear, and service rooms in the center, connected to a lightwell ("Luftschacht"), which provided ventilation to the kitchen. All units were equipped with electricity and central heating. Some apartments reached up to 250 square meters in floor area. Anyone wishing to construct a building within the estate was obligated to comply with these strict guidelines. While the interior layout was standardized across all buildings, the external appearance was not uniform, as the architectural articulation of façades was not subject to regulation. This allowed individual architects to express stylistic variation and creativity, contributing to the visual diversity of the district while maintaining spatial coherence (Barłóg, 1989, p. 108-135).

The garden city concept, formulated by Ebenezer Howard at the turn of the 20th century, envisioned a balanced environment that combined the advantages of urban and rural life (Howard, 2015). In practice, this meant designing settlements with extensive greenery, low-rise and dispersed housing, shared communal spaces, and a functional urban layout that promoted both privacy and social integration. The guiding idea was to create a healthy, aesthetic, and community-oriented environment as an alternative to the overcrowded and polluted industrial cities. The first implementations of this vision were Letchworth Garden City (1903) and Welwyn Garden City (1920) in the United Kingdom, designed by Raymond Unwin and Barry Parker. Although Howard's original concept was meant for large-scale urban developments, its principles were widely adapted for smaller residential areas, particularly working-class housing estates. In the case of Johow-Gelände, we observe a unique adaptation of these ideas: a concept originally rooted in socialist reform was applied to a luxurious residential district, accessible only to the wealthiest inhabitants. Moreover, only the aesthetic and sanitary aspects of Howard's model were retained, while elements related to community life and access to services were omitted—wealthy residents did not require commercial infrastructure within the district, as domestic staff handled everyday errands such as shopping. Located in Poznań's Łazarz district, Johow-Gelände reflects several core principles of Howard's theory: low-density development, abundant greenery, and semi-private gardens intended to foster neighbourly relations. Ultimately, one of Howard's key propositions—the integration of green spaces into the urban fabric as a response to rapid industrial urbanization—is clearly visible in the estate's design. However, while the garden city was envisioned to improve the living conditions of the working class, in Johow-Gelände the theory was used to construct a prestigious enclave for the urban elite. Grzeszczuk-Brendel posits that this historicism may stem from the ideological cohesion of the broader Imperial District, which favored monumental forms associated with prestige and imperial authority. The national identity of the district's residents also remains a subject of debate. While address books suggest that most inhabitants were German officials and military personnel, the presence of Polish residents challenges the oft-repeated claim in literature that Poles were forbidden from residing in these new districts (Grzeszczuk-Brendel, 2018, p. 104). Barłóg (1989, p. 108-135) emphasizes that the elite nature of the housing—not formal exclusion—likely limited Polish residency, although state policy certainly favored German settlement. Kodym-Kozaczko (2009) supports this interpretation, arguing that segregation was actively enforced through urban planning that reinforced national division. This represents a significant moment in the evolution of the tenement block (rental apartment) as a typology in modern European cities. By the outbreak of World War I, only three of the seven housing blocks planned by Max Johow had been realized—along Matejki and Grottgera streets. The further development of the district was halted by the war and subsequent structural changes related to the postwar reconstruction of Poznań. After Poland regained independence in 1918, the construction of buildings continued according to earlier guidelines. As a result, the character of the estate was preserved throughout the interwar period. After the end of World War II, Poznań was left in ruins, with approximately 55% of its urban fabric destroyed, and the historic city center nearly obliterated (Mazur, 2020). Particularly devastating was the loss of municipal infrastructure—including water supply, sewage systems, gasworks, and power plants—which significantly hampered the city's reconstruction efforts. Over half of all buildings were damaged, and 20% of residential units were rendered uninhabitable, creating a major housing crisis, especially amid population influx and the shortage of construction materials (Kempiński, 2020). In response, the authorities of the Polish People's Republic were compelled to develop a comprehensive reconstruction strategy—one that not only addressed immediate needs but also aligned with the long-term ideological and economic objectives of the new socialist regime (Crowley, 1994, p. 87-203). The communist government adopted an urban planning model rooted in the modernist paradigm of reconstruction and urban industrialization. Drawing inspiration from Le Corbusier's principles as well as Soviet spatial planning models, the state aimed to create functional residential estates that served both practical and ideological purposes (Juszkiewicz, 2023, p. 46-81). This was not merely a technical solution, but a tool for shaping the new socialist citizen—an individual embedded in a collectivist, standardized living environment that sought to eliminate class and economic inequalities. A key solution in this vision was the implementation of large-panel (prefabricated) construction technology, which enabled the rapid, mass-scale production of standardized apartment blocks. The housing estates designed in the 1950s and 1960s, such as Rataje and Winogrody in Poznań, were conceived as self-sufficient residential units equipped with essential public services, including schools, clinics, and shops. This model—inspired by Clarence Perry's "neighborhood unit" theory—sought to optimize living space in terms of efficiency and functionality (Lawhon, 2009, p. 111-132). These new districts also became symbols of social mobility, offering improved living conditions and the promise of a better future for working families. As a result, prewar districts such as Johow-Gelände, once a symbol of urban luxury, gradually lost their appeal. Moreover, most properties in these areas were transferred to municipal ownership and repurposed under state housing policies. Formerly spacious apartments—some nearly 200 square meters—were subdivided into communal flats ("komunałki"), where multiple families shared a single kitchen and bathroom (Kotus, 2007, p. 140). This significantly reduced the standard of living, especially in contrast to the new apartments built with large-panel prefabricated technology, which came to symbolize progress and modernization for many Poles, who used to live in the countryside before. Interviews conducted with residents as part of this research indicate a substantial socio-demographic shift in the population inhabiting Johow-Gelände after World War II (An interviews with: Mr. Paweł

Cieliczko, resident of Matejka 55, conducted by the Authors on March 28, 2025; Mrs. Maria Stankiewicz-Strzykała, the manager of the tenement house at Wyspiańskiego 10 from 1960 to 1989, conducted by the Authors on April 15, 2025.; Documentation of the interviews in the form of notes is in the possession of the Authors). While these tenement houses had previously been occupied by members of the educated and socially advantaged social class members and middle class, the postwar urban reality brought an influx of working-class residents and rural migrants, many of whom were unaccustomed to urban life. This contributed to the progressive degradation of inner-city districts, in sharp contrast to the panel block estates, which attracted young families and became emblems of socialist modernity. According to records held by the Office of the Municipal Heritage Conservator, the original design of the tenement houses provided for two spacious apartments per floor (Municipal Heritage Conservator's Office in Poznań, heritage records (conservation cards) of tenement houses located at 50–61 Matejki Street and 1–16 Grottgera Street.) Fieldwork conducted during site visits to residential buildings on Matejki and Grottgera Streets revealed material traces of these spatial transformations. The functional layouts of these units bear clear marks of adaptation to the postwar housing crisis, including shifted partition walls, additional subdivisions, and ad hoc technical installations, all indicative of the subdivision of original apartments into smaller living units (The Office of the Municipal Conservator of Monuments in Poznań, documentation of the tenement houses at Matejki 51, Matejki 55, Grottgera 2, applications regarding renovation and construction, and project documentation).



Fig. 3. Example of spatial degradation: the originally planned green courtyard between tenement houses has been replaced by a concrete yard used for parking and waste disposal. This tendency began after 1945 and continues to this day, 2025 (photo by the author).



Fig. 4. View of the façades of tenement houses at 55–60 Matejki Street, 2025 (photo by the author).

Although these changes were made with the aim of utilizing space more efficiently, they ultimately led to the degradation of both spatial coherence and quality of life. The nationalization of property also brought about a major shift in property management (Zakrzewski, 1985, p. 405). Prewar owners, even if permitted to remain in their buildings, were relegated to the role of caretakers, stripped of ownership rights and denied rental income, which resulted in a progressive transformation of ownership structures. The absence of clear accountability for building maintenance led to systematic physical decline, a trend that became particularly visible in the 1970s and 1980s, when years of neglect in maintenance and conservation caused the architectural substance of many buildings to deteriorate (fig. 3). The lack of effective funding mechanisms, fragmented tenant structures, and a chronic shortage of building materials further contributed to the loss of both the functional value and aesthetic integrity of historic tenements. A notable exception to this pattern is the tenement at 10 Wyspiańskiego Street, which uniquely preserved its original interior layout (An interview with Mrs. Maria Stankiewicz-Strzykała, the manager of the tenement house at Wyspiańskiego 10 from 1960 to 1989, conducted by the Authors on April 15, 2025. The interview documentation in the form of written notes is held by the Authors.) The absence of significant spatial alterations is due to ownership continuity—the building remained in the hands of the same family throughout the postwar period, enabling it to avoid the typical changes associated with municipalization and nationalization. This case supports the thesis that continuous private ownership and the ability to exercise effective management are critical factors in the preservation of architectural authenticity. It was not until after the political transformation of 1989 that the complex process of reprivatization began. However, protracted legal proceedings and ambiguous regulations surrounding property rights greatly hindered the restitution of real estate to prewar owners or their heirs.

Contemporary revitalization efforts indicate a gradual, albeit uneven, improvement in the technical condition of historic tenement buildings. According to documentation from the Office of the Municipal Heritage Conservator in Poznań, the period 2015–2025 saw a number of comprehensive restoration projects, encompassing both structural modernization and the conservation of architectural details. (fig. 4) A notable example of successful revitalization is the group of tenement houses on Matejki Street, which underwent extensive renovation in 2023. At the same time, however, many buildings—including those at Matejki 54, 57, and 58—remain in poor technical condition and are in urgent need of large-scale conservation interventions. The past decade has witnessed a visible intensification of renovation activities, yet a comprehensive restoration of the Johow-Gelände urban complex still faces significant obstacles. These include financial constraints as well as the complexity of administrative and legal procedures.

Discussion

The first and, to date, most comprehensive publication dedicated to the Johow-Gelände residential complex on Matejki Street in Poznań was authored by Jolanta Barłóg in 1989 as a master's thesis titled *The Residential Complex on Matejki Street in Poznań on the Site of the So-Called Johow-Gelände, 1900–1918*. It was this study that first introduced the subject into academic discourse. It is striking that for several decades, the topic remained largely unaddressed. On one hand, the 1990s marked the beginning of broader interest in residential architecture; on the other, the omission may have been tied to the communist authorities' reluctance to engage with urban heritage closely associated with German cultural legacy. In the era of propaganda emphasizing the "eternal Polishness" of territories incorporated into the Polish state after 1945, references to a district commonly known as "Johow-Gelände" would have been politically inconvenient. Among scholars, the greatest uncertainty concerns the authorship of the district's master plan and individual buildings. Barłóg (1989, p. 54–61) noted that attributing the urban plan to Max Johow is not definitive; it is possible that Josef Stübben—a key urban planner, chair of the Royal Commission for the Expansion of Poznań, and author of the city's Ring—may have been involved, but due to the absence of archival documents, this cannot be confirmed. In *Architecture of Poznań 1890–1918* (1991, p. 105–107), Jan Skuratowicz (1991) emphasizes that Stübben's involvement should be analyzed more closely, given the district's elite character and its close ties to state planning. He argues that the area was inhabited primarily by senior state and military officials and that Stübben was likely responsible for plotting Matejki Street (then *Neue Gartenstrasse*) and organizing the newly incorporated districts of Poznań. This argument is reinforced by Jolanta Goszczyńska (1998) in her *Investors and Residents of the So-Called Johow-Gelände*.

In later studies, authors offer more nuanced views of the architectural authorship. In broader syntheses such as Janusz Pazder's *Atlas of Poznań Architecture* and Grażyna Kodym-Kozaczko's *Space, People, Ideas: Urban Planning of Poznań in the 20th Century* (2008), Johow is typically credited as the primary planner. However, scholarly debate continues, particularly regarding the eclectic design of the façades. One central issue is classification: whether the architecture should be considered Art Nouveau or represents a more complex stylistic situation. Barłog notes that while the buildings borrow ornamental motifs associated with Art Nouveau, the structural forms themselves do not conform to the principles of that style. In a later publication, she analyzes select tenement houses within the complex in relation to both historicism and Art Nouveau (Barłog, 1989, p. 82-104.). Skuratowicz identifies the façade at Matejki 51 as inspired by Viennese Secession, while Grzeszczuk-Brendel suggests the presence of Scottish influences in the building at Chełmońskiego 9, though without providing specific supporting evidence. Among the more historically styled examples are the Neo-Baroque villa of Max Johow at Matejki 50 and the tenement at Matejki 54, which evokes medieval architectural forms. The national identity of Johow-Gelände's residents remains debated. While German officials and military personnel were predominant, the presence of Polish inhabitants challenges claims of outright exclusion, with scholars like Grzeszczuk-Brendel, Barłog, and Kodym-Kozaczko suggesting that elite housing and urban planning reinforced German settlement and national segregation. Much uncertainty still surrounds the Matejki Street complex, and many questions will likely remain unresolved due to the loss of archival materials during the 1945 Battle of Poznań. To date, the subsequent fate of the district has not been comprehensively studied. Previous works have primarily focused on the initial development phase of Johow-Gelände. This article aims to suggest further research possibilities by offering a broader historical narrative that takes into account the later stages of the district's transformation.

Conclusion

The history of Johow-Gelände serves as a poignant example of how urban space can become a stage for the realization of political, ideological, and social projects that extend far beyond the realm of urban planning. The case of this district shows that space is not neutral—on the contrary, it is inscribed with the history of power shifts, social transformations, and struggles for the identity of the city. From a luxurious settlement designed in the spirit of Prussian modernism and German cultural dominance, through post-war degradation resulting from PRL policies, to contemporary attempts at revitalization—Johow-Gelände reveals the long-term consequences of urban planning decisions rooted in specific political and ideological contexts. Changes in the functional, ownership, and social structure of this district are a testament not only to the history of Poznań but also to the broader transformational processes that took place in Central and Eastern Europe in the 20th century. Johow-Gelände thus becomes a case study that allows us to understand how regimes—both authoritarian and democratic—use space to shape society, design everyday life, and impose visions of social order. This district is not merely a collection of buildings; it is a living narrative about the tensions between the past and the present, about continuity and ruptures in the urban landscape. The analysis of Johow-Gelände highlights that spatial decisions are never purely technical—they are, above all, political. Contemporary revitalization efforts must take this complex history into account and treat heritage not as a collection of monuments, but as a dynamic process of interpreting and co-creating urban identity. Finally, the conclusion may end with a forward-looking statement, proposing directions for further research, potential applications, or unresolved questions that merit deeper exploration. This leaves the reader with a sense of continuity and relevance, showing that while the chapter has reached its end, the topic remains dynamic and open to further development within the academic or professional discourse.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 9

Revitalisation of Darb-e-Ghasr Historic Quarter, Isfahan, Iran

* Dr. Narmin Babazadeh Asbagh

Introduction

Isfahan is one of Iran's ancient cities, famous for its magnificent buildings, especially from the Safavid era. Darb-e-Ghasr is one of the historic neighbourhoods in Isfahan, which consists of many gorgeous houses and precious landmark buildings. Although this historic quarter is rich in valuable cultural heritage, it suffers from a lack of awareness and neglect of significant buildings. This article proposes effective methods for revitalising the Darb-e-Ghasr neighbourhood in Isfahan, Iran. After comprehensive research about the neighbourhood's needs, the proposals for improving and revitalising this momentous context are suggested exhaustively. This historic research is based on qualitative and quantitative methods and the personal observations of the author. The results of this article can be useful for preservationists and conservationists in the field of cultural heritage, as well as architects and urban planners for designing in the historical context of ancient cities.

Isfahan is one of Iran's ancient cities, with many remarkable historical sites and masterpieces unique to the history of architecture worldwide. Isfahan is called "Nesf-e Jahan" in the Persian language which means "half of the world" due to the abundance of the famous historic buildings in this historical city and most world travellers, adventurous tourists, and European ambassadors visited and wrote about their personal experiences during staying and visiting them in so many books (Abouei, 2023, pp. 5, 12-13). Isfahan is one of the three main historic cities in the world, according to the books and publications of worldwide researchers and specialists about Iran and the Middle East (Honarfar, 2008, p. 51).

The first part of this article is about Isfahan City in general, and the second part introduces the neighbourhood and historic quarters of Isfahan and the Darb-e-Ghasr neighbourhood. The third part comprises road lighting, walking routes, floor coverings, and infrastructure. The fourth part is about the research results, project and questionnaires with design ideas and proposals for revitalisation, followed by the fifth part of conclusions and suggestions.

Isfahan, the Beautiful City of World Travellers

Among the cities of Iran, Isfahan has a special position in the eyes of foreign tourists. Consequently, they found it more beautiful than other cities, even after the Afghan invasion, which had left only a trace of the past. Fred Richards, a tourist who came to Iran during the period when Tehran was the capital, described Isfahan as a city that "unlike other cities in Iran, has still preserved traces of its past glory that can be offered to travellers." According to his belief, in most of the cities of Iran, holy buildings are found with ruined and slippery walls that have been kept up by the crumbling soil and the decay of centuries like a barrier, but none of these buildings has the attraction of Isfahan's historical monuments. Eugene Flandin, who visited Isfahan during the period of Mohammad Shah-e Qajar, agrees with Richards that "without exaggeration, Isfahan is one of the greatest cities" (Flandin & Coste, 1851, p. 159). Pietro Della Valle, an Italian tourist who visited Isfahan in the period that was the beginning of the prosperity of Isfahan during the era of Shah Abbas Safavid, considered this city incomparable in the Middle East and considered only Constantinople to be equal to it. In this case, "compared to Constantinople... Isfahan is not only equal in many ways but it can be boldly said that it is superior" (Delawaleh, 2012, p. 35).

Chardin, who visited Isfahan during its greatness, considered Isfahan and its suburbs to be "one of the greatest cities in the world" (Chardin, 1983, p. 33). Based on this, the capital of the Safavids had previously occupied the minds of foreign tourists, and they had an image of Isfahan that was different from other cities. The picture was distorted by seeing the city during the Qajar period. A tourist who set foot in Isfahan during the period of Naser Al-

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How to Cite This Chapter:

Babazadeh Asbagh, N. (2025). Revitalisation of Darb-e-Ghasr historic quarter, Isfahan, Iran. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 70-94). Cinius Yayınları.

<https://doi.org/10.38027/N9ICCAUA2025EN0121>

Din Shah Qajar expressed his observations: “I have to admit that we were shocked when we arrived in Isfahan. How did we expect the city to be so populous and beautiful before entering there? They called it half of the world and one of the most famous cities in the Middle East. Let's see them in front of us. But what we saw, unfortunately, was the opposite of these ideas and expectations. In front of us was a dry and empty land, dilapidated houses, palaces, and ruined mosques that were once considered masterpieces of art” (Brugsch, 1988, p. 364). The chaos of Isfahan began with the attack of the Afghans, and during the period of Nader Shah-e Afshar, it became a “desolate city”, so that “people left some neighbourhoods in one place” and abandoned their homes. According to Jean Otter, “This heartbreaking situation is the current Iranian cities” (Otter, 1984, p. 89).

After the Safavid era, Isfahan gave its place to other cities in the political system, and this caused the rulers to not pay attention to it: “Although Nader Shah-e Afshar paid attention to it, Isfahan is as important as Mashhad in his opinion”, Karim Khan-e Zand also moved the capital to Shiraz, Agha Mohammad Khan-e Qajar moved the centre of government to Tehran and destroyed the fortifications of Isfahan, and Fath-Ali Shah-e Qajar sometimes visited that city... or the current Shah, Mohammad Shah-e Qajar, also honoured there with his presence only once in 1851. According to what has happened, Isfahan has fallen from its glory and dignity, and now, with its ragged and dusty society, which is not an unnecessary metaphor for the current state of the city, it mourns its lost glorious days (Curzon, 1971, p. 30).

In the destruction of the historical and artistic works of Isfahan, two factors, “hands of fate” and “insensitive rulers”, have been involved. In the meantime, Edward Browne placed more emphasis on the factor of the rulers, which he believed stems from their way of thinking: “The way of thinking of the sultans and rulers of the East is surprising. Because they destroy the works of the past or neglect them to be destroyed, and instead create buildings that preserve their names and works, they no longer understand the works of sultans and generations of the past. They destroyed them, and the sultans and other generations that will come in the future will also destroy their works” (Browne, 2012, p. 300).

For more information about the Qajarid historic houses in Isfahan, an article titled “Comparative Analysis of Qajar Historic Houses in Tabriz, Isfahan, Yazd, and Kashan, Regarding their Architectural Forms and Elements”, written by the author, can be read (Babazadeh-Asbagh, 2022a, pp. 586-605).

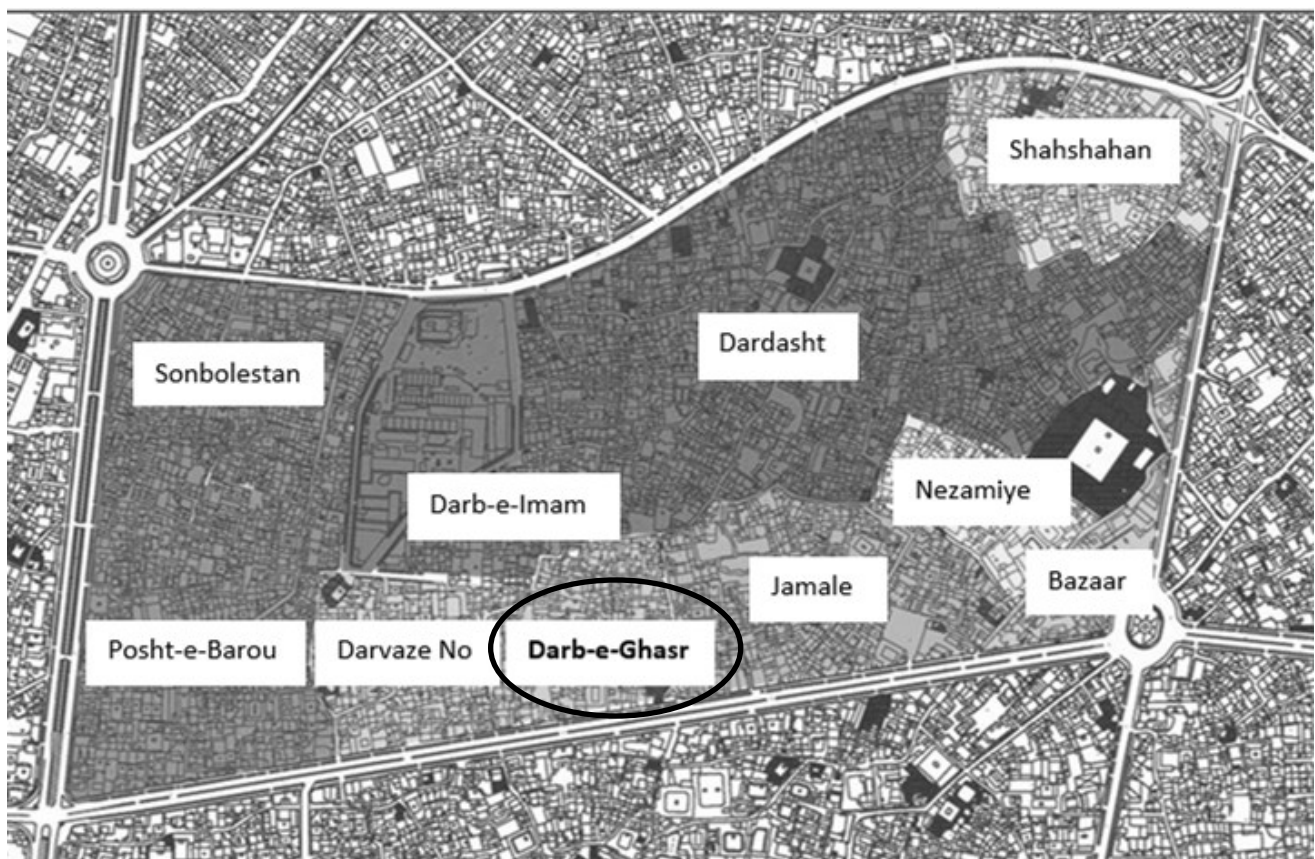


Figure 1. Location of Darb-e-Ghasr in the Map of Old Neighbourhoods of Isfahan (Developed by the Author Based on one of the Maps of the Archive of Maskan and Shahrsazi Organisation of Isfahan, 2010).

Old Neighbourhoods of Isfahan

The old neighbourhoods of Isfahan are: 1- Lanban, located in the northwest; 2- Bagh Karan, located in the southeast, which is known today as Khajou; 3- Chanbalan, which is known as Sonbolistan; 4- Karran; 5- Jouybareh, and 6- Dardasht. After Isfahan expanded, the number of its neighbourhoods increased to the point where about forty small and large neighbourhoods formed the city of Isfahan. The names of some of the old neighbourhoods of Isfahan were: Mahallat Dolat, Bagh Jannat, Abbas-Aabad, Lanban, Chaharsu Shirazi, Shams-Aabad, Charkhab, Hassan-Aabad, Khajou, Trovaskan (Tal Wazgon), Zillah, Paghla, Qasr-e Monshi (Monshi Palace), Karran, Ahmad-Aabad, Yazd-Aabad, Golbahar, Jouybareh, Toqchi, Dardasht, Shah-Shahan (Shahshahan), Asanjan, Felfalchi, Chambalan, Jamala Kale, Nimaverd, Hakim Mosque, Darvaze Nou, Bidabad, Shish, Darkooshk, Mahalle Nou, Musthalak, Mornan, Khaojan, Baghat, Sheikh Yousef, Old Square, Letour, Goud Maghsoud Bek, Chenar Sokhte, Heydarkhaneh, Bagh Homayun, Qiblah of Prayer, Sin Paini, Gulbar, Pain Darvazeh, Faqala Froushan, Takht-e Gonbad, Posh Matkash, Jolfa, Sichan, Marnan, Hussein-Aabaad, Qaynan, Khalja, and some other small and large neighbourhoods. Some of these large neighbourhoods themselves include several smaller neighbourhoods. Such as the Jouybareh neighbourhood, which includes Mir Square, Dar-Al-Batikh, Seyyed Ahmadian, Darb-e-Daricheh, Sultan Sanjar, Bashakh, and Yaldzeh Pich. Most of the above neighbourhoods still exist and are known by the same original names (See **Figure 1**).

Old Isfahan consisted of two old and famous neighbourhoods: "Jouybareh", which was called "Nemat-Ol-Lahi" or "Nemati", and the other, "Dardasht" neighbourhood, which was called "Heydari". The residents of the Jouybareh neighbourhood were Shia (Muslims), while the residents of Dardasht were Sunni (Muslims). For this reason, for centuries, the two neighbourhoods of Heydari and Nemati have been long-standing enemies of each other and thirsty for each other's blood, and all histories and documents refer to the differences and hostile encounters between these two groups. The savage Mongols invaded Isfahan, and the Shafi'is helped them by opening the fortified gates of Isfahan to them, hoping to destroy the Hanafi sect. When the savage Mongols took control of the city, they slaughtered both sects with their sharp blades, making no distinction between the Hanafi and Shafi'i sects. After the construction of the Grand Mosque of Isfahan in the Yahudiyeh neighbourhood, the following fourteen neighbourhoods were established in that area: Batarqan, Farsan, Jarvan, Pavan, Kharjan, Felflan, Sonbalan, Fara'an, Kama'an, Lanban-e-Ashkahan, Khashinan, Bruskan, Khabjan, and Jawzdan (Reports of Isfahan Cultural Heritage and Tourism Organisation, 2009). For obtaining more information about the historic neighbourhoods of Isfahan, another article written by the author entitled "Tomb of Sultan Bokht Agha and Two Minarets of Dardasht Neighbourhood in Isfahan, Iran" can be studied (Babazadeh-Asbagh, 2022b, pp. 12-26).

An Introduction to the Knowledge of the Neighbourhood

The traditional and residential parts of the cities of the Islamic world, including Iran, are made up of neighbourhoods that have a special structure. In Islamic lands, the Islamic city can be considered a set of homogeneous regions and localities. The groups living in these areas have maintained their identity, religion, and ethnicity for centuries. The separation between these areas or the set of neighbourhoods in the Islamic city is very strong. These areas are usually made up of several neighbourhoods where people with the same language, religion, profession, family, and origin have lived next to each other. The people in their neighbourhoods had close relationships, constant connection and solidarity, and faith and belief (Mashhadizadeh Dehaqani, 1994, p. 22). The most interesting feature of neighbourhoods in traditional Iranian cities was the lack of separation of social classes in them. The rich were not grouped separately from the poor in exclusive groups. In many cases, the rich and the poor lived in the same neighbourhood, and sometimes, they were wall to wall. There were many reasons for this, the most important of which was the religion of Islam, which encouraged the coexistence of the rich and the poor (Khodaabadi, 1997, p. 107).

Definition of the Neighbourhood

The simplest definition of the neighbourhood can be stated as follows: the neighbourhoods were the residences of ethnic, racial, and religious groups and owners of different professions. The neighbourhood is derived from the Tazi language, which means "Kuy" and "Barzan", and it is one part of several parts of a city, village, town, and residence, and the place of landing and the place of people (Nafisi, 1938-1939, p. 1381). A neighbourhood is an area of the settlement that is separated from other areas (Da'e'ul-Islam, 1926, p. 78). Farhang-e Ghaffari defines the neighbourhood as follows: neighbourhood, barzan, kuy, and road, a quarter of any number or any part of something that is divided into four parts (Ghaffari, 1956, p. 98). Locality: the landing place of a part of the city, Kuy, Barzan, the total of (Amid, 1964, p. 1773) neighbourhoods in the city of Cairo is ten neighbourhoods (Moein, 1985, p. 3922).

This definition can also be found in European languages, such as "Quarter" in English, "Quartier" in French, and "Viertel" in German, which means a quarter. The origin and application of a quarter to urban areas has a historical origin that originates from the overall shape and structure of cities. Ancient cities were usually divided into four residential parts by a road network or a public road perpendicular to each other. In the past, the boundaries of neighbourhoods were determined by religious, social, and similar criteria, and today, due to changes in the

classification of social and economic status in cities, the criteria of the past have almost disappeared. According to another definition of a neighbourhood, it can be said that a neighbourhood is part of a city. It is so that its residents can meet their daily needs in the same place. Even though the places are the product of human thought and initiative, after their appearance, these are the places of life. They shape them and draw them into personal deposits (Shakoyi, 1979, p. 113). In the end, in general, the neighbourhood can be considered as a small part of the city or settlement, where the residents have some social, economic, political, ethnic, cultural and religious goals, or the owners of professions and even the urban origin, and can be a common village.

Neighbourhood Components

The neighbourhoods of Iranian cities, especially Isfahan, have a special geographical unity in their texture and structure. Alleys, crossings, neighbourhood centres, and public facilities work together and give existence to neighbourhoods. Each of these components has its own characteristics, which are of particular importance in terms of the traditional fabric of the cities. Elements, collections, and spaces such as bazaars, mosques, baths, saqqakhanehs (water deposits), and in the traditional and large neighbourhoods of caravanserais (inns), zourkhanehs (traditional sports saloons), and meidanches (small squares), were created to meet the needs of the residents of each neighbourhood and give them relative independence in their lives. The components of the neighbourhood are residential houses, alleys and dead ends, and public facilities such as places of worship, sports places, and coffee houses. These elements are usually evenly distributed throughout the city (Shafaqi, 2004, p. 147) (See **Figure 2**).

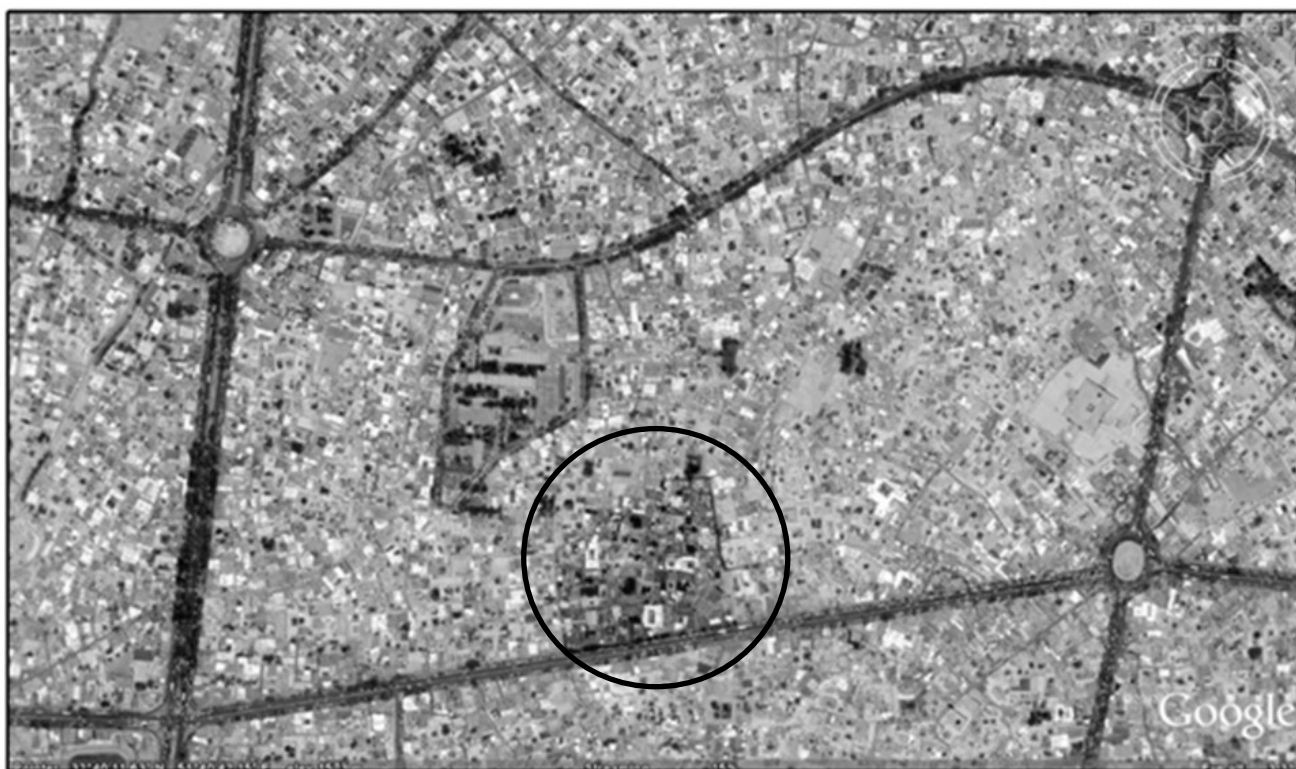


Figure 2. Location of Darb-e-Ghasr Neighbourhood in the Google Maps of Isfahan (Developed by the Author based on Google Maps).

Urban Landscape

Every environment is like an information reservoir containing information that is related to the realities in it, and every person faces a lot of potential information when facing their environment, although, for various reasons, it is not possible to receive all the information in the environment. As a receiver, man is only able to receive a part of the information sent from the transmitters around him. Man can only feel and then perceive a part of what exists in reality, which is called the urban landscape. Therefore, the urban landscape is that part of the urban environment or the city form that is effective on personal action and reaction and the results of their actions. It is in the urban landscape that a part of the information of the potential environment is transformed into a directly perceptible quality or actual information. In this way, the discussion of the city landscape does not only have a visual aspect, but it is a part of the environment that can be perceived by one or more of the five senses. It is obvious that in a normal state, a person is not able to perceive the whole city and only perceives a part of the city in which he is located; this part is usually an urban space. Man in the urban space with human and non-human factors: physical and non-physical.

In connection with the concept of “mental image”, we can say that as a receiver, humans receive and perceive information through their senses, view, and then analyse it in their brains and compare it with their mental meanings. It is in this analysis that social-psychological factors, such as individual personality and individual and collective experiences, play an essential role, leading to the creation of a mental picture of reality. This mental image, in turn, affects a person's behaviour. Information processed in the mind, the mental image of the perceived environment or space, is called an “image”. This term, which is borrowed from Lynch's book, “The image of the city”, should not be confused with the term “scape”. Unfortunately, since urban appearance and urban landscape are often used synonymously in colloquial conversations, therefore, both terms are used in the explanations of each of the related laws and regulations. These rules are, as it was mentioned that they are specifically aimed at the urban landscape (Lynch, 2023, November).

View

The façade is the external and visible part of the building. Each building is seen from at least one side and at most from four sides, depending on the way it is connected to other buildings and the position of the establishment in the road network. For example, a single building can be seen from all four sides. A building located on a street corner has at least two façades. Row buildings have two main and secondary views. Normally, views that can be seen from public spaces are called main views. In this collection, the façade refers to the vertical surfaces of buildings visible from the passages, either their main façades or their side façades, which are visible from public spaces. The number of views that can be seen at far and near distances naturally changes with the observer's viewing angle, and it also depends on the characteristics of the observation location, such as the location of the observer on the floor or a height, and even the height of the closest building to the observer, etc. The effective factors in the façade, especially in the main façade of the building, the material and colour, the shape and dimensions of the openings, the size or smallness of the façade, which takes its dimensions from the height and volume of the building, the ratio of transparent to opaque surfaces on the surface of the façade, entrance dimensions; they are indentations and protrusions and the architectural style of the building and so on.

Body

Bodies are three-dimensional vertical volumes that define space. Just as each volume is made up of multiple external surfaces, the body is also formed from the continuity of vertical surfaces on both sides of the space. These volumes may not be connected and may be separated due to the presence of undeveloped lands. Naturally, the body is not formed as a continuous and straight surface, and it is also obvious that the height of a body is not the same if the height of the buildings is different in its different positions. Also, the façades that participate in the formation of the body must not be off the main façade type, but parts of the length of the bodies of the passages may be formed from the side façade of some buildings or even from the wall. In the residential streets between city blocks, each block consists of two rows of north and south buildings connected; the northern boundary is the wall of the courtyards and entrances of the northern buildings.

In terms of the participation of façades overlooking the thoroughfare in the formation of the body of streets and passages, all the factors affecting the façade that were mentioned earlier, type, colour, materials, and the shape and dimensions of the openings in the façades overlooking the thoroughfare, the size (height and width) of the façade, dimensions entrance, architectural style, etc. affect the appearance of the body, and in addition to these, the facilities on the roofs, such as ventilation facilities, shelters (bumps), the shape of the roofs (flat, sloping, convex), chamfers, shop name boards, building names and street names, and even advertisements mounted on the walls, etc. also affect the view of the body. It should be added that symmetry and balance in the bodies on the sides of the streets are very effective factors in their landscape quality.

Floors

The meaning of floor is the limiting element of the lower space, which is usually a horizontal or inclined surface. The surface of streets and squares and green spaces and water features in the middle of them, sidewalks, walkways, large open areas, such as the space between residential complexes and large apartment complexes, wide green surfaces, sanctuaries, as floors free of construction or with limited construction, green surfaces on the sides. Streets and gardens (parkways) and in the middle of streets and boulevards, tables, canals and rivers, bridges connecting pedestrians and pedestrians, urban open parking lots, fences in the middle of streets or barriers between pedestrians and walkers, vehicle entry barriers to sidewalks, valves, and covers of infrastructure such as sewers and the like are placed in the floor area. In terms of flooring and paving of passages, slope, type of materials (asphalt, stone, mosaic, etc.), dimensions of material pieces, the colour of materials, motifs and geometric designs, use of green spaces and tree plantations, use of surface differences, are effective and popular.

Urban Furniture

Street furniture or equipment or urban furniture, refers to the elements that are installed to facilitate the passage, safety, and comfort of passers-by, provide some public services to all citizens, and help improve the quality

of the environment in urban spaces. The most prominent elements of furniture, include canopies of bus stations, benches, bus ticket counters, public telephones, mailboxes, bank ATMs, donation boxes, boxes related to electricity, waste bins, tanks, taps, drinking springs, fountains, newspaper kiosks, street pots, metal guards around newly planted tree trunks, metal plates around tree trunks in connection to the ground, sculptures, all kinds of lights with different lights, heights, and shapes, guidance and driving signs, boards with various information about the city, notice boards and advertisements, etc.

Views for the Design of Residential Centres

- Access.
- The use of children, young people, adults, the elderly, and cyclists.
- Use for leisure time (play, fun, meetings, rest, walking).

The demand for car parking places and its related facilities in densely populated places where the need for space and accuracy in its use is mandatory if the usable area for each car is considered to be 30 square meters in residential areas. At different times of the day, the number of parking spaces to be created can be less. So that every car that comes to the centre has a parking space for it, which is designed for a multi-house complex with separate pedestrian and car roads. The facilities for creating a place to stop the car are designed in such a way that there is a very short distance to the place of residence. Due to the lack of sufficient space around the residential units, this space inevitably becomes one of the spaces used by people, that is, private and public spaces are somehow integrated into each other, and as a result, the possibility of using vehicles is minimised and pedestrians are also exposed to various dangers, and the noise of vehicles and environmental pollution, etc., apart from the fact that it affects the people on the roads, but also those who are at home are safe, does not leave and as a result reduces the value of residential spaces be made.

Road Lighting

The light should be even, and there should be no dark spots. The idea of creating green space with suitable weather is one of the most important factors on Earth and in nature. Humans should always try to preserve the scenery of nature, keep the environment clean from pollution, and clean the air they breathe. Paving the surface of the Earth causes the temperature to rise. Constructing in the middle of the green space is the best situation for the evaporation of suitable weather in changing the polluted air.

The main factors of air pollution:

- Car smoke.
- Smoke from household appliances.
- Smoke from industrial factories.

The places where people live permanently must have environmental conditions.

Walking Routes

Residential areas, playgrounds, meeting neighbours, borders, kindergartens, primary schools, social and medical institutions, and cultural institutions. The historical effects and attractions of a city can be pondered in terms of cultural, economic, and social status, and paying attention to these factors in interventions is one of the important points that show the city's identity.

Floor Coverings

Covering the walkways in the green space with a floor covering of sand bonded together with painted asphalt. Sidewalks can be paved with red or grey concrete slabs, with natural stones and bricks. Sewer valves should be avoided in bicycle lanes. Infrastructure issues of society:

- Elderly and youth home.
- Health and treatment centres.
- Education and support centres.
- Psychotherapy Centre.
- Cultural and entertainment centres.

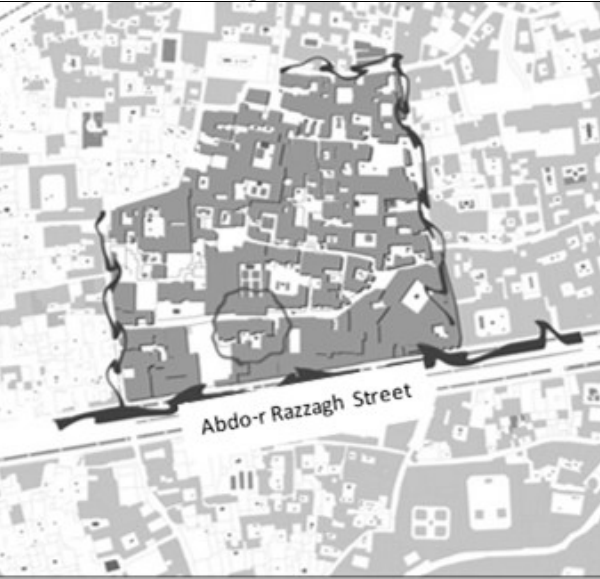
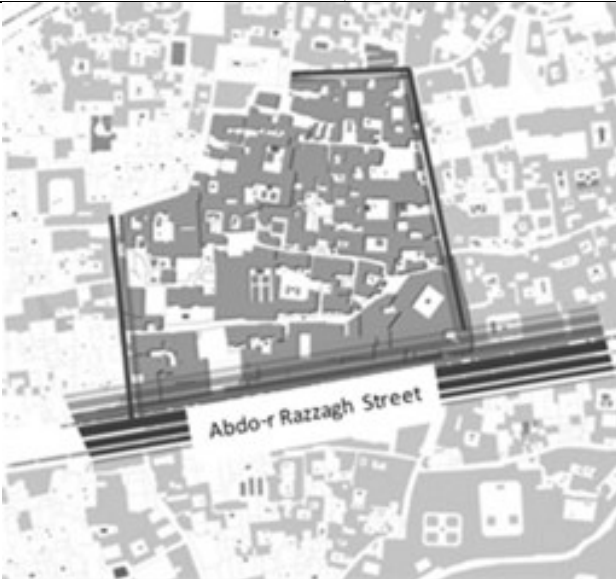
Infrastructure

Facilities to meet the needs of the place: Water piping, simple and mixed channelling, channelling for sewage disposal, channelling for water and rain disposal, electrical wiring, gas piping, telephone communications, creating water sources on site, water pumping stations, distribution boxes for telephone lines. Facilities to meet public needs in a larger area of the site: conducting surface water in narrow cables, conducting gas from long distances, and conducting high-pressure electricity from a distance. The interrelationship between traffic and construction: The construction of some buildings will affect traffic. Based on this, their type, size, and usage should be determined, and traffic divisions, traffic patterns, etc., should also be discussed.

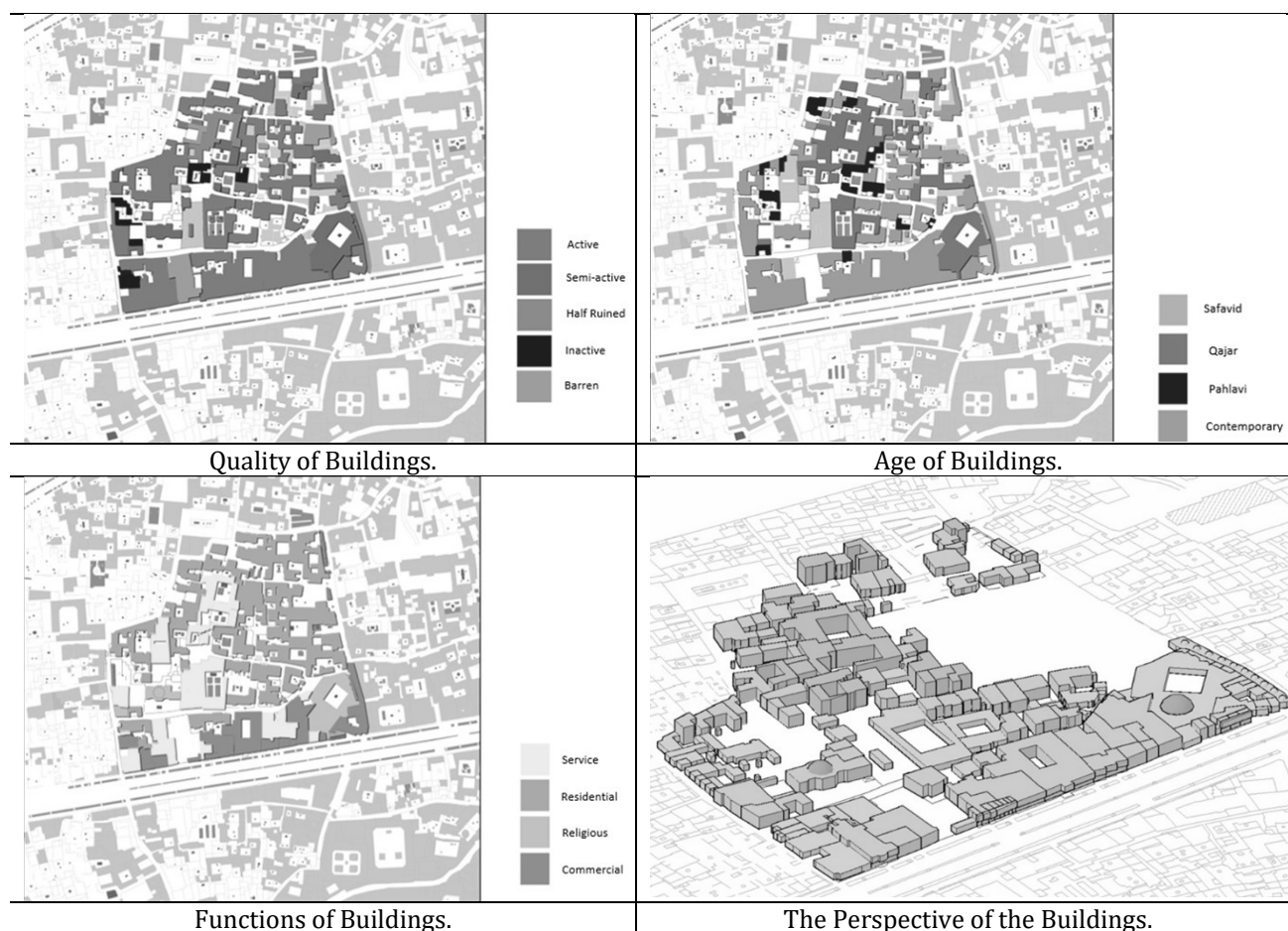
Results from the Research about Darb-e-Ghasr Neighbourhood

The dominant material in the façades of most buildings in this neighbourhood is brick. The water circulation system in this neighbourhood was a qanat in the past, and today, it is a piped water system. The majority of the walkways are paved with asphalt, with paving stones used only in certain areas. The rainwater drainage system is implemented through gutters embedded in the façade. The dominant body in the outer part of this part, which overlooks Abdo-r Razzagh Street, is commercial, and in the inner parts, residential. The majority of buildings in the neighbourhood are residential, with only a few religious buildings and several buildings with commercial use. Most of the buildings in this context are in an undesirable and inconsistent contemporary manner, with their originality lacking any special value, and there are only a few landmark buildings in the neighbourhood. Most of the residents in this neighbourhood are long-time residents who have lived here for over 20 years. Security in this area is very good, according to its residents. Most residents are dissatisfied with the renovations made to some of the neighbourhood's walkways. Most residents have a low cultural level. There is a parking problem in the neighbourhood. The city's historic landmarks have been abandoned and are uninhabited. The minimum height in this part of the neighbourhood is about 3.4 meters. The maximum height in this part of the neighbourhood is about 10 meters (See **Table 1**).

Table 1. Maps of the Analysis of the Site of Darb-e-Ghasr Neighbourhood in Isfahan (Developed by the Author).

	
Sunlight Direction.	Access from the Adjacent Roads.
	
Air Pollution.	Noise Pollution.





Social Problems

Table 2. Social Problems of Darb-e-Ghasr Neighbourhood in Isfahan (Developed by the Author).



Problem 1: Lack of public parking and parking of cars in an unorganised and arbitrary manner. Solution: Designing parking in the neighbourhood.



Problem 2: Lack of public trash cans, cats tearing trash bags, and unpleasant odours from sewage in the neighbourhood. Solution: Designing trash cans.



Problem 3: The presence of electric poles and hanging electrical wiring on the façades. Solution: Remove electric poles and design wall lights.



Problem 4: Presence of gas piping and gas valves on the façades. Solution: Creating a gap in the façade and inserting the pipes into it is a definitive solution, and if this is not possible, painting the gas pipes in a colour that matches the façades is a temporary solution.



Problem 5: A Wide variety of door and window types on façades. Solution: Design of type and modular doors and windows.



Problem 6: Sticking advertising Stickers on doors and façade walls. Solution: Design advertising boards.



Problem 7: The dilapidated space is being turned into a parking lot and a garbage dump. Solution: Design a parking lot and empty the garbage.



Problem 8: Too much variety of materials in façades and too much variety of colours. Solution: Design façades that are coordinated in terms of materials and colours.



Problem 9: Buildings without façades. Solution: Design and implement a façade.



Problem 10: Lack of proper carpet floor design (inappropriate asphalt and carpet floor). Solution: Proper carpet floor design.

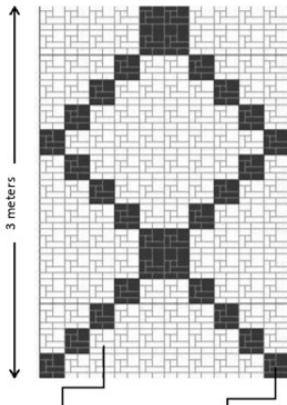
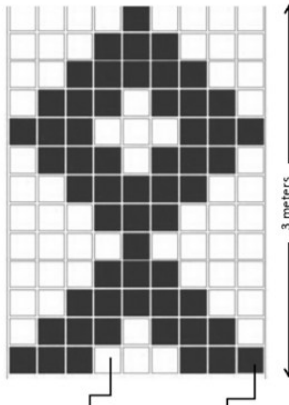
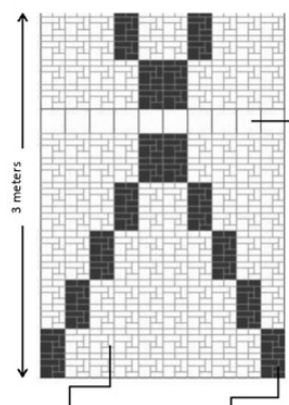
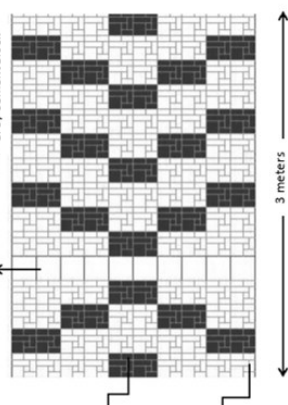
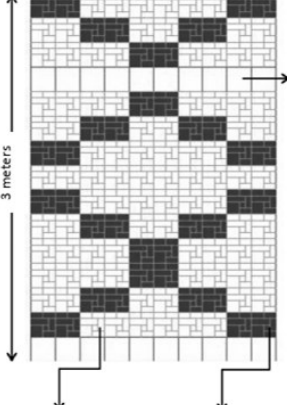
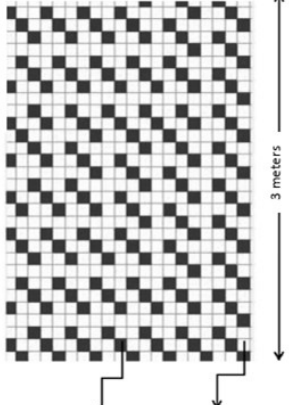
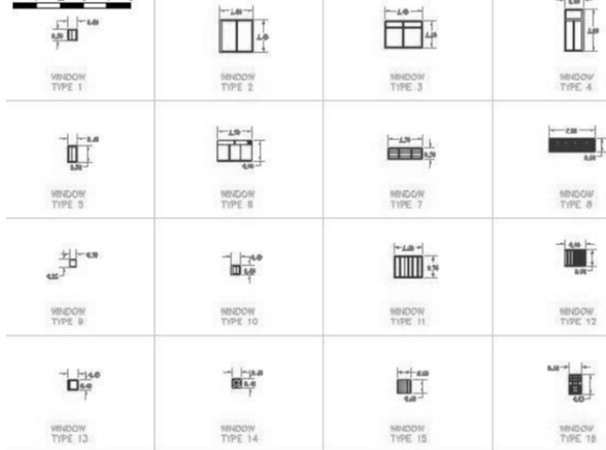


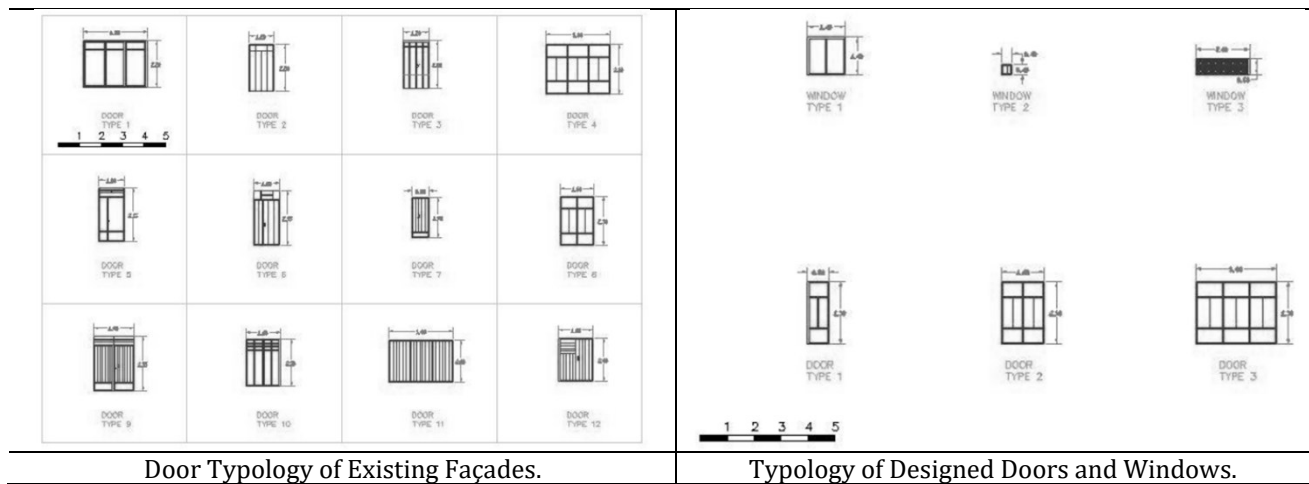
Problem 11: Inconsistency in the brickwork of the façades. Solution: Proper design and implementation of the bricks in the façades.

Neighbourhood Problems

- Lack of green space.
- Lack of space for neighbours to interact.
- Improper flooring.
- Lack of trash cans and some neighbourhood spaces becoming trash areas.
- Lack of appropriate urban furniture.
- Lack of fire prevention measures.
- Lack of proper façades of buildings.
- Cracks in the façades of buildings.
- Rising humidity in buildings due to problems with the gutters of buildings.
- Low cultural level of residents of the neighbourhood.
- Failure of officials to use the potential of the neighbourhood to promote and improve the neighbourhood.
- Lack of proper parking.
- Lack of proper space for children to play in the neighbourhood.
- Lack of a clinic or polyclinic within and near the neighbourhood.
- Existence of dilapidated buildings.
- Failure of the authorities to restore the historical buildings of the neighbourhood.
- The presence of numerous chimneys on the façades of buildings.
- Completely inappropriate façades of buildings and vandalism by the residents themselves.
- Construction of buildings of inappropriate and inconsistent height in the neighbourhood.
- Diversity in façade materials and colours.
- Diversity in the doors and windows of buildings.
- Inappropriate skyline (See Table 2).

Table 3. Design Ideas for Darb-e-Ghasr Neighbourhood in Isfahan (Developed by the Author).

 2 meters 3 meters Yellow Carpet Brick Red Ochre Carpet Brick		 2 meters 3 meters Grey Cement Block Red Ochre Cement Block		 2 meters 3 meters Grey Carpet Brick Red Ochre Carpet Brick		 2 meters 3 meters Red Ochre Carpet Brick Grey Carpet Brick	
Different Types of Designed Carpet Floors.				Different Types of Designed Carpet Floors.			
 2 meters 3 meters Grey Carpet Brick Red Ochre Carpet Brick		 2 meters 3 meters Red Ochre Carpet Brick Grey Carpet Brick		 1 2 3 4 5 WINDOW TYPE 1 WINDOW TYPE 2 WINDOW TYPE 3 WINDOW TYPE 4 WINDOW TYPE 5 WINDOW TYPE 6 WINDOW TYPE 7 WINDOW TYPE 8 WINDOW TYPE 9 WINDOW TYPE 10 WINDOW TYPE 11 WINDOW TYPE 12 WINDOW TYPE 13 WINDOW TYPE 14 WINDOW TYPE 15 WINDOW TYPE 16			
Different Types of Designed Carpet Floors.				Typology of Existing Windows of Façades.			



Parking Design

There are a total of 22 residential units adjacent to the under-construction passage, 10 of which have private parking inside the building in the form of a yard or garage, and the other 12 units do not have parking or are unable to drive their cars to their yards due to the narrow width of the passage. A parking lot with a capacity of 27 vehicles has been designed on the vacant plot of land and the square adjacent to this passage, with the dimensions of each car parking space being 2.5 meters by 5 meters (See **Figure 3**).



Figure 3. Parking Design (Developed by the Author).

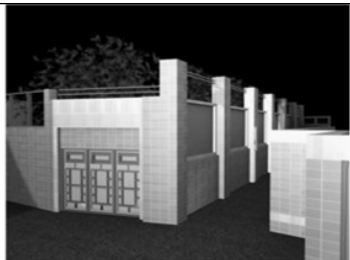
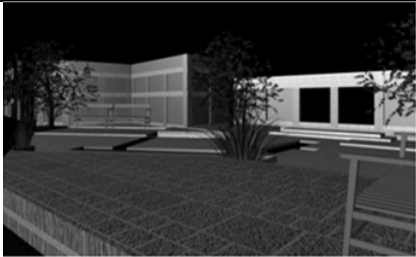
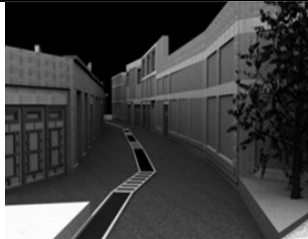
Design Ideas

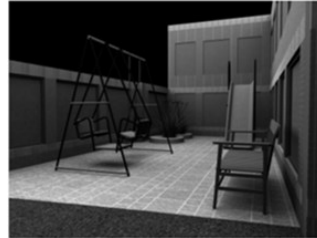
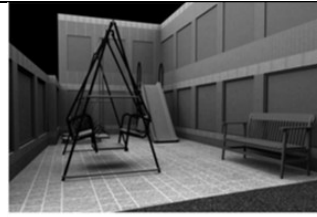
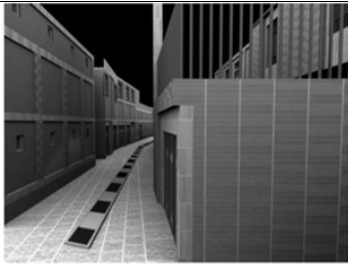
- Take inspiration from existing templates for framing and modules in façade construction.
- Design the façade in such a way that a suitable skyline is achieved.
- Use appropriate and proportionate materials in façade construction.
- Design and implement an appropriate lighting system.

- The colour of doors and windows should be considered appropriate for the historical context, and an appropriate and modular design should be used for them.
- Design appropriate intermediate elements to create a hierarchy in the passage.
- The design has tried to consider a separate pedestrian path so that no problems or dangers threaten pedestrians and residents, and they can easily engage in their social interactions.
- Design a clean and tidy public space for greater communication between neighbours and the community of residents of the neighbourhood.
- Design a play area for the children of the neighbourhood.
- Design a suitable lighting system for the passage, for example, using wall lights.
- The height difference of the green space designed with the passage creates a sense of a separate space from this space and also increases the security of the residents in this space (See **Table 3**, **Table 4**, & **Table 5**).

Proposed Design in the Passage

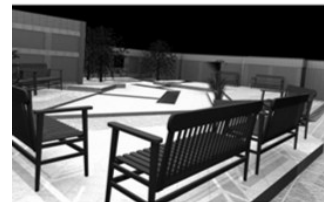
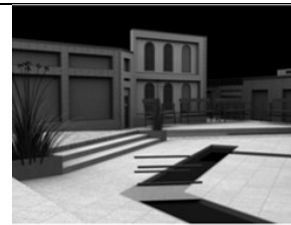
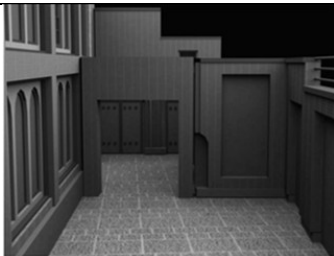
Table 4. Current Pictures and Design Ideas for the Darb-e-Ghasr Neighbourhood (Developed by the Author).

  	 
In this design, modularity was used in the body, the materials were selected following the historical value of the traditional passage, and the problem of the gas valve was solved by hiding it deep in the façade.	Water was used in this design, and the materials were also appropriate for designing a recreational pedestrian passage that leads to a green space. The materials were also selected to be appropriate to the historical value of the traditional passage, and the problem of electrical wires was solved by hiding them in a box that matches the building's façade.
  	  
This design attempts to design a recreational space for residents and green space in the neighbourhood, and the materials have also been selected following the historical value of the traditional passage.	Water was used in the design to design a recreational pedestrian passage that leads to a green space, the materials were selected to suit the historical value of the traditional passage and modularity and framing were used in the façade.



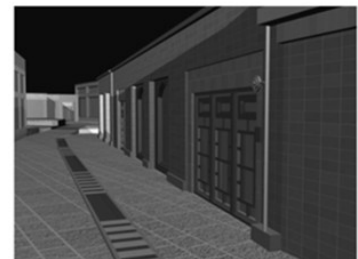
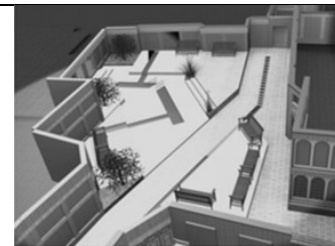
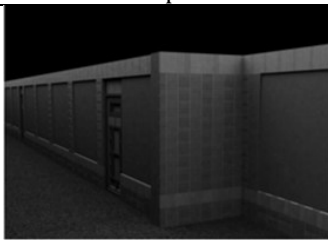
Water was used in this design, materials were selected that were appropriate to the historical value of the traditional passage, modularity and framing were used in the façade, and the skyline of the passage was also modified.

An attempt has been made to use a dilapidated space in the design of a play area for local children.



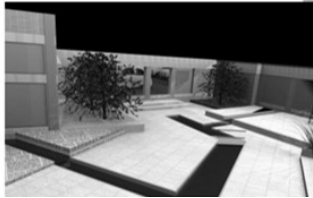
An attempt has been made to design a suitable intermediate space to create a hierarchy in transition.

An attempt has been made to design a green space for interaction and communication between neighbours.

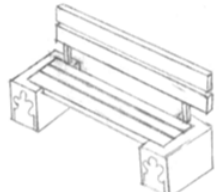
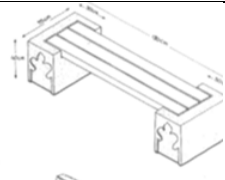


An attempt has been made to design a façade with appropriate framing, and a modular door designed for this façade has been used.

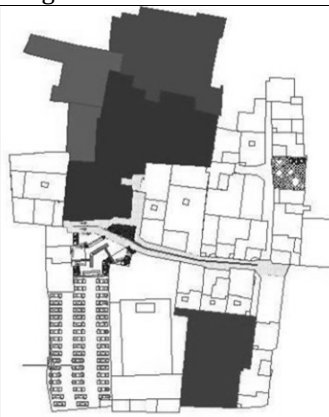
Pedestrian crossing and green space are designed at the crossing.



Lack of green space design and square design in a parking lot. Design the field as a green space, and design the space behind the field as a parking lot; in which case, access from the parking lot to the passage must be designed.

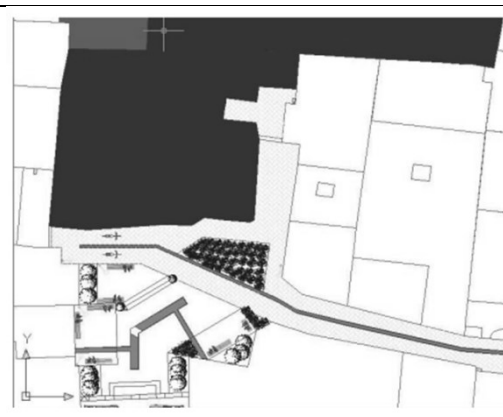


Suggested designs for the vase, benches, and lights. The column decorations of the Toghralian house, from which the idea for the furniture design was taken.

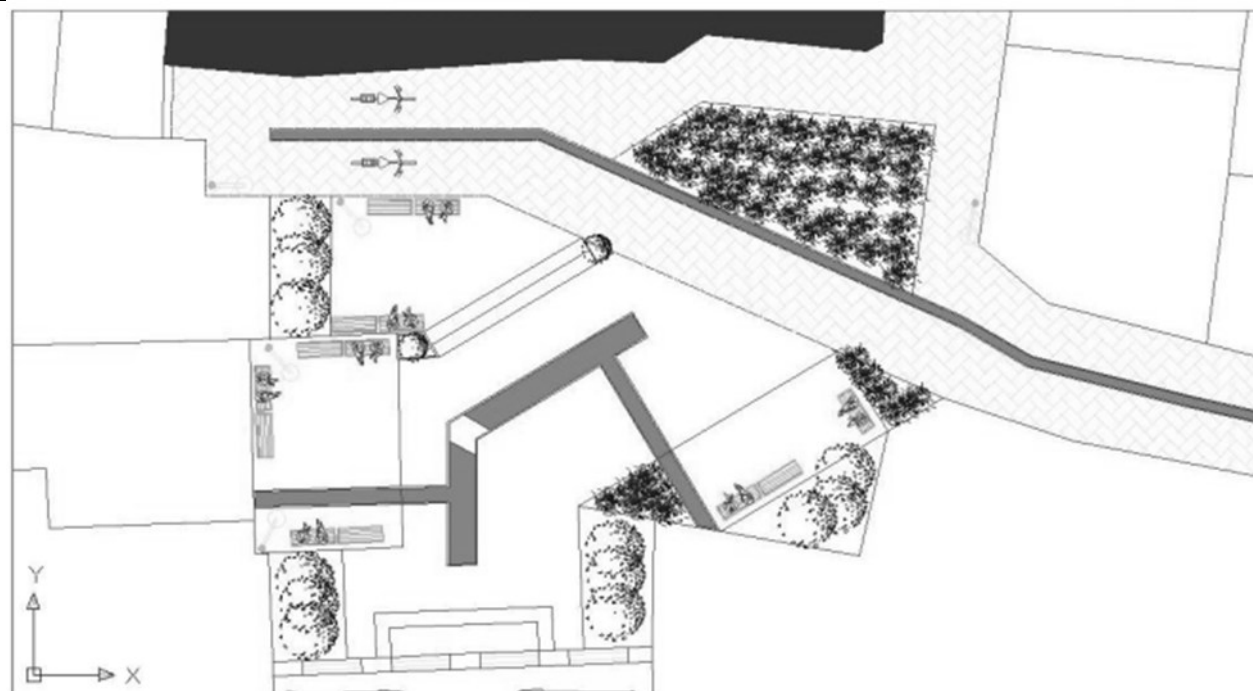


Heritage Organisation Office in the Neighbourhood
Crafts School and Exhibition
Provincial Inn
Library
Clinic
Green Space
Designed Flooring
Fountain

Suggested Uses for the Neighbourhood.



Designed Green Space for the Neighbourhood.

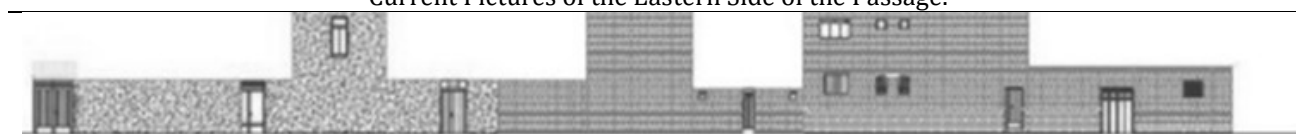


Plan of the Square as a Proposed Designed Green Space in the Neighbourhood.

Table 5. Current Pictures, Existing and Designed Views of the Passages of Darb-e-Ghasr Neighbourhood in Isfahan (Developed by the Author).



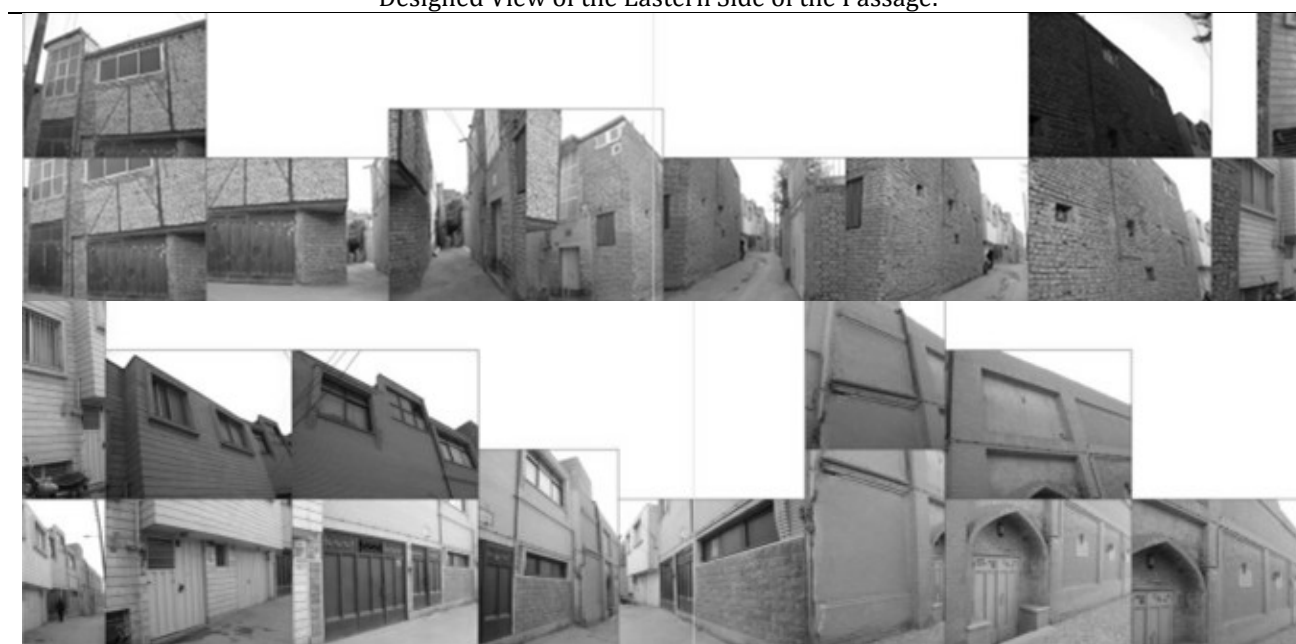
Current Pictures of the Eastern Side of the Passage.



Existing View of the Eastern Side of the Passage.



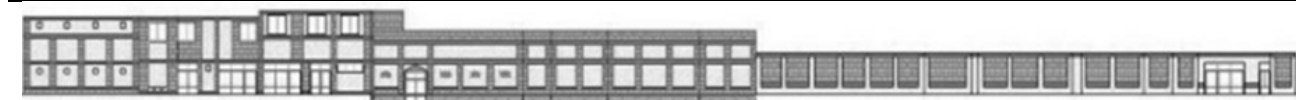
Designed View of the Eastern Side of the Passage.



Current Pictures of the Southern Side of the Passage.



Existing View of the Southern Side of the Passage.



Designed View of the Southern Side of the Passage.



Current Pictures of the Western Side of the Passage.



Existing View of the Western Side of the Passage.



Designed View of the Western Side of the Passage.



Current Pictures of the Northern Side of the Passage.



Existing Views of the Northern Side of the Passage.



Designed Views of the Northern Side of the Passage.



Questionnaire Results

The results of the filled questionnaires are summarised in the following table (See **Table 6**).

Table 6. Summary of the Results of the Questionnaires (Developed by the Author).

Authenticity of Habitants	Old Habitants				New Habitants			
	56%				44%			
Gender of Habitants	Female				Male			
	50%				50%			
Gender of Children	Daughters				Sons			
	42%				58%			
Shopping Centre	Bazaar of Neighbourhood		Main Square		Around the Workplace			
	42%		35%		23%			
Building Materials	Brick - Steel		Clay		Steel - Concrete			
	67%		19%		14%			
Occupation of Family Head	Free Job		Government		Retired		Jobless	
	68%		9%		17%		6%	
Green Spaces	Houses Without Yard		With Yard Without Green Spaces		Houses With Trees		Houses With Plants	
	18%		32%		25%		25%	
Family Numbers	1 Family per House		2 Families per House		3 Families per House		No Inhabitants	
	54%		24%		10%		12%	
Consent of Families	Fully Consent		Average Consent		Indifference		Not Consent	
	40%		32%		8%		20%	
Current Situation	Good Condition		Week Condition		Need Restoration		Need Urgent Restoration	
	85%		15%		41%		6%	
Origin of the Building	New		2 nd Pahlavi		1 st Pahlavi		Qajar	
	36%		20%		6%		16%	
Ownership Type	Private		Government		Vaghf		Rental	
	63%		10%		13%		11%	
Architectural Values	Cultural Value		Aesthetic Value		Architectural Value		Historical Value	
	4%		13%		8%		19%	
Spending Free Time	Going to the Park		Religious Ceremonies		Staying at Home		Going out of the Neighbourhood	
	24%		24%		39%		8%	
Education of Family Head	Illiterate		Primary Education		Diploma of High School		Undergraduate	
	24%		25%		38%		10%	
Facilities	Water		Electricity		Telephone		Gass	
	82%		82%		82%		82%	
Length of Habitation	1-5 Years		5-10 Years		10-15 Years		15-25 Years	
	24%		11%		6%		19%	
Floor Numbers	1 Floor		2 Floors		3 Floors		More than 3 Floors	
	26%		24%		12%		3%	
Façade Material	Brick		Façade Brick		Mud		Clay	
	45%		9%		7%		10%	
Education of Inhabitants	Female Illiterate		Male Illiterate		Female No Diploma		Male No Diploma	
	14%		10%		18%		15%	
	Female with a Diploma		Male with a Diploma		Educated Female		Educated Male	
	11%		15%		12%		5%	

Discussion and Conclusion

In the previous renovations carried out in a part of the passage and the square leading to it, nothing other than the economic aspects were considered, nor the demands of the residents, the needs of the place, nor the aesthetic aspects in this restoration of the floor of the passage, made of cheap stone. An unfair price has been used because the residents are dissatisfied with this paving stone, and it is difficult to travel on. There is no difference between the façade of the restored buildings and the state before restoration, and after a few years the façade of the building, which is in the vicinity of the rain and dust is placed in the air, so it has been changed in colour and thatched to the colour of the buildings before restoration. The existing landmark buildings have no specific cultural and social use and are only for residential purposes, and as a result of this use, they have been forgotten again after some time. At the same time, in the former renovations, the landmark buildings have not been made valuable, as a result, a special design has not been done to reveal and highlight these historic buildings. In addition, the problem of facilities has not been thought of, and the parking lot considered did not meet the needs of the neighbourhood.

The designed passage is considered a sidewalk passage with regularly shaped brick paving stones, although the top surface of these blocks was ordered to be slightly uneven in production so that there is no problem of slipping and, as a result, the problem of residents' commuting is solved. At the same time, the passage can be used locally for residents to ride bikes, so that the residents sometimes gather together and have a group activity. As a result, passage number two is considered a bicycle passage and the passage leading to the square as a sidewalk, but the communication way should be designed between crossing two and the pedestrian path, and considering a parking lot in that part is proposed. Due to its proximity to Isfahan Aqiq Bazaar and Haj Mohammad Jafar Bazaar, the designed structure does not need a shopping centre. However, it lacks any space for the collective activities of residents, a clinic, a cultural space, a library, and most importantly, a green space and a pleasant space for recreation, as all the residents go to other parts of the city for recreation. Additionally, the neighbourhood does not have any space to collect the garbage of the neighbourhood, so proper garbage dumps should be designed next to some houses.

The neighbourhood in question also has a problem with lighting, which needs to be installed in several areas with appropriate lighting. If implemented, the proposed plan will revitalise the fabric. The designed green spaces will bring vitality back to the neighbourhood, and the trash cans will help clean the neighbourhood. The intended uses for inactive and abandoned buildings will both save the fabric and several architectural indicators, and raise the level of culture in the neighbourhood, and life will flow in the fabric. The problem of parking for residents will be solved, and even the intended parking lot will have the capacity of the multi-use space created in the plan. The clinic is considered due to the lack of this user in the neighbourhoods that provide services to the adjacent neighbourhoods, and as a result, the problem of accessing a doctor in the neighbourhood is also solved. The considered library will act as a reading centre for the residents, and as a result, the literacy level of the neighbourhood will increase. Similarly, the Isfahan Handicrafts Museum and School will both revive these arts and make people refer to this neighbourhood from other parts of the city to this neighbourhood. The foundation considered for the heritage also supervises the restorations and actions carried out in the intended area and adjacent neighbourhoods, and as a result, the risk of the area's destruction will be eliminated. The proposed guest house will undoubtedly be a place where many tourists will want to spend their time in this neighbourhood due to its proximity to Aqiq Square and the Grand Mosque of Isfahan. Finally, as a result, the area will be revitalised greatly, which will also result in the prosperity of Haj Mohammad Jafar Bazaar and Isfahan's Aqiq Bazaar.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The author takes all the pictures and draws, edits, and extracts all the figures of the maps from the AutoCAD programme. The author translates all the English text from the Persian Language. This research is the result of the merging of two projects about the historic quarter of Dardasht and Darb-e-Ghasr neighbourhood in Isfahan, Iran, by the author under the supervision of Associate Professor Dr. Reza Abouei at the Art University of Isfahan during Master's studies of the author in the Fall and Spring Semesters of 2009-2010 Academic Year. This article was accepted for online presentation at the 8th International Conference of Contemporary Affairs in Architecture and Urbanism held by the Architecture Department of Alanya University, Alanya, Antalya, Türkiye, and presented at the aforementioned conference from 8-9 May 2025 (Babazadeh-Asbagh, 2025, May 2).

Conflict of Interests

The author declares no conflict of interest.

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Chapter 10

Predictive Routing for Airborne Monitoring of Heritage Areas

* Salvatore Polverino, Rokhsaneh Rahbarianyazd

Introduction

The principal guidance for the conservation of the environment, cities, and buildings has been meticulously developed by supranational governing bodies such as UNESCO (United Nations Educational, Scientific and Cultural Organization) and ICOMOS (International Council on Monuments and Sites) (Zaina, F. et al., 2022). These organizations serve as political barometers, with the UNESCO World Heritage Committee annually elucidating interpretations of architectural heritage conservation.

The objective and rationale of urban development significantly impact historical cities. Liang, Wen, et al. (2023) assert that mere conservation of buildings is insufficient, emphasizing the need for heritage and sustainable development to progress in tandem, as articulated in the 2011 Recommendation on the Historic Urban Landscape. This endorsement highlights contradictions between architectural heritage conservation and modern urban development, arguing that the rigid and dogmatic connotations of the 1964 Venice Charter are obsolete; from this viewpoint, history and development are seen as mutually beneficial contexts (Najd Deghati, M. et al., 2015) in the act of preserving the lexicon of urban heritage (Nia, H. A et al., 2017).

The urgency to safeguard archaeological parks and monuments in urban areas, both before and after conflicts, is evident (Barakat, S., 2021). This relevance aligns with the latest orientations from the 2005 Vienna Memorandum by UNESCO and the 2015 Recommendation for the Protection and Promotion of Museums and Collections, stressing the importance of protecting and preserving cultural heritage in museums. This includes safeguarding collections from risks such as theft, damage, degradation, and natural disasters, with a focus on advanced technological integration of digitalization.

As a consequence, the air-digital interaction was first recognized in 1954 under the canonical aspect of armed conflict, followed by the 1999 Second Protocol of the Hague Convention, which introduced enhanced protection for cultural sites of significant importance. ICCROM's Course on First Aid to Cultural Heritage in Times of Crisis trains cultural heritage professionals to provide immediate assistance to damaged cultural assets during conflicts, covering damage assessment (Chizzoniti, G. et al., 2023), site stabilization, and collaboration with local communities and humanitarian agencies. Despite these efforts, challenges arise from the qualitative exploration of Electronic Warfare (EW) and its impact on energy and monitoring systems (Leijonhufvud, Gustaf et al., 2021) delving into a functional approach of the built surroundings (Loulanski, T., 2006), e.g. for context-responsive historical landscapes (Di Mauro, L. et al., 2024) in line with its derived bunker archeology (Schofield, J., 2009) and anti-aircraft shelters (Rosser, P. et al., 2024) addressed to newfound gentrification definitions with an "allied alteration" in the built environment (Rahbarianyazd, R., 2017). Parallel to this, we acknowledge an intrinsic separation between physical heritage buildings and their social use applying economic evaluations as a correction factor of urbanism (Madrigal, J., 2018) and energy audits (Richards, J., et al., 2022) via sensor-based architecture, critical for institutional building management. Research databases notably lack information regarding conflicts involving heritage, except for physical and classical inscriptions (Borja, A., 2021), historically used to demonstrate moral victory over another civilization.

Contemporary threats involving detonations and artillery, combined with the physical confiscation of property by armies, as outlined in 10 U.S. Code § 2579 - War booty (Feis, H., 2016), highlight the shift to digital services. An

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How to Cite This Chapter:

Polverino, S., & Rahbarianyazd, R. (2025). Predictive routing for airborne monitoring of heritage areas. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 95–123). Cinius Yayınları.

<https://doi.org/10.38027/N10ICCAUA2025EN0141>

increase in qualitative factors, is yearly portrayed by the UNESCO Cultural World Heritage Sites (WHS) which has recently shared a boost of input variables following the definition of Outstanding Universal Value (OUV). As Roha W. Khalaf (2017) mentions, "If a World Heritage property is destroyed and later reconstructed, could it still be recognized as World Heritage?". This issue involves a signal about invisible forces in the aerial ether, with author Khalaf (2017) posing questions about the initiation, technical training, construction materials, guidelines, impact assessments, and assessment team for reconstruction.

Emerging from the EW context and cyberspace (Choi, S. et al., 2020), volatile data related to cultural, moral, and scientific supremacy emphasize the impact of military data acquisition and the display of such data as a form of spatial conquest. Subsequently, a marginal bibliography regarding the quantitative manufacturing aspect of Unmanned Combat Aircraft System (UCAS) considers data inputs in estimation matrices.

Nonetheless, significant non-disclosure due to classification poses severe research limitations, including adversarial UAS (Unmanned Aircraft System) aeronautical data (Balcerzak, T. et al., 2022), in large part unreleased, and the hypothesis of a designated archaeological zoning buffer under EW pressure.

This hypothesis is supported by previous departmental research advocating for no-strike lists along Italian borders against foreign forces in the Mediterranean basin for battlefield key terrain models (Spennemann, D., 2020) favoring Heritage Building Information Modeling (HBIM) (Spennemann, D., et al., 2019).

Parallel to ICCROM-UNESCO Outstanding Universal Value guidelines, this research examines an advanced outlook of EW supervision, concentrating on predictive national prevention strategies, as illustrated in the Aerial view retrieved from Google Earth Imagery of Figure 1 (a).

To reinforce the paradigm, we focus on enhancing Situational Awareness (SA) for the southernmost region of Italy, specifically along the southwestern coast of Sicily, as illustrated in Figure 1 (b), an area acutely vulnerable to non-European influences; this region aims to protect identity-bound historical landmarks (Hamurcu, et al., 2020; Brosché, et al., 2016), which have been neglected during wartime, as noted by Hoeniger (2024).

Key for peacetime context evaluation, the X-47B UCAS is designed to carry various EW payloads, including jammers and Electronic Intelligence (ELINT) receivers, enhancing its operational versatility (Sozinov, A., et al., 2023), e.g. its carrier-based takeoff and landing capability makes it suitable for coastal surveillance and amphibious operations in adverse weather; given its exclusive purpose as a demonstrator, it's designated to prompt critical assessments of its cost-effectiveness and the strategic value of continued development in observance to this unmanned aerial vehicle detection category (Seidaliyeva, U. et al., 2023) and their implied anomaly (Wu, Y. et al., 2024).

In last instance, the rationale behind this study relies on the intricate protection of this settlement, as seen in Figure 2 (a), serving as an exemplary case study for EW management, emphasizing the heterogeneous land cover of the Selinunte Park and its adjacent areas, highlighted in Figure 2 (b).

This locale is characterized by a wide range of buffering zones, thereby presenting a complex and rich environment for the application of EW strategies (Chetverikov, B., Babiy, L. et al., 2024).

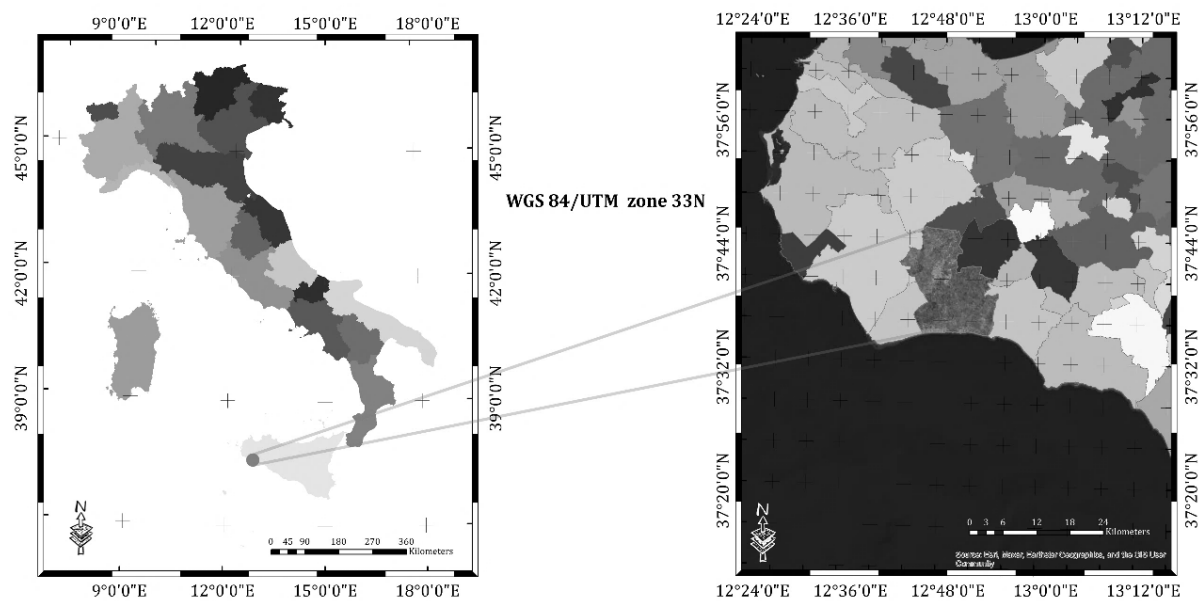


Figure 1 (a) National context and (b) Regional overview highlighting deployment area.

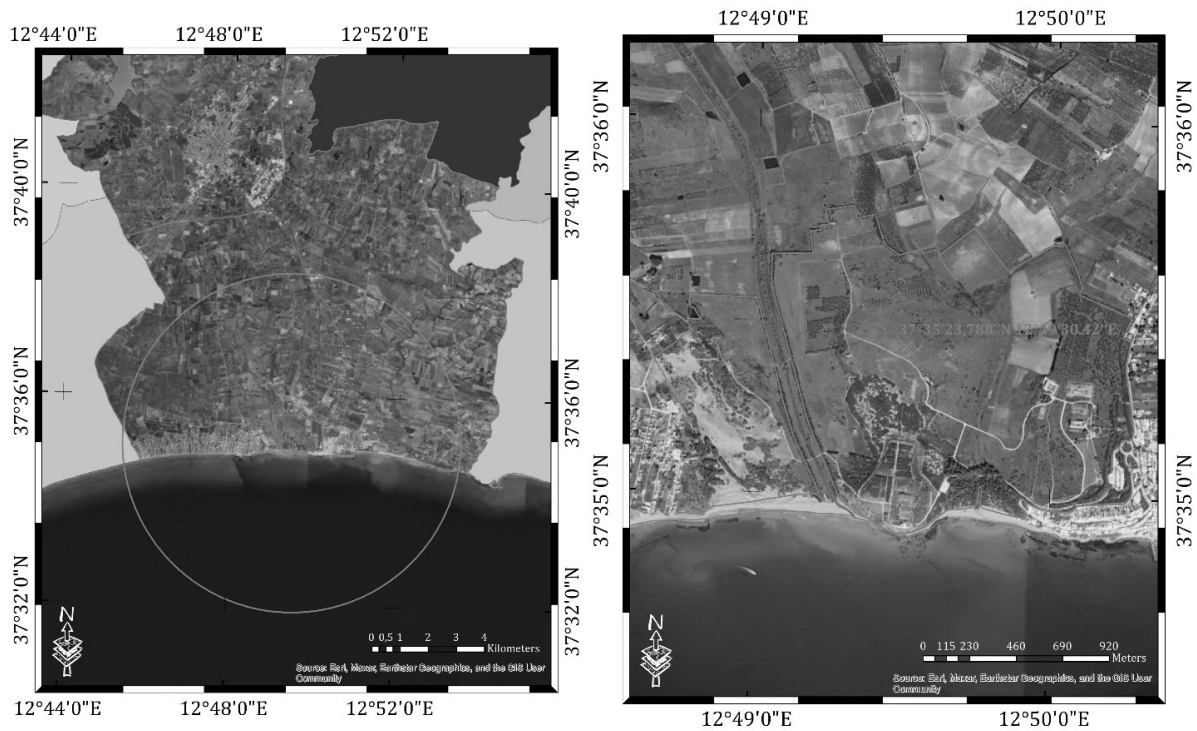


Figure 2 (a) Close-up of the operational area and (b) Detailed aerial view of deployment site.

1.a. Literature Review: pioneering unmanned demonstrators for carrier operations

Through rigorous analysis, we select the most pertinent deployment methodologies, commenced in Figure 3, with a detailed examination of orientations to improve EW supervision and UCAS positioning.

By establishing a hierarchical decision-making framework based on three phases, the research incorporated a binary decision-making process, explicitly delineating “yes” and “no” choices to avoid regression and ensure consistent progress.

This systematic approach is divided into three essential phases: i) Preparation Phase; ii) Weighting Calculation Process, and iii) Decision-Making Appraisal Phase.

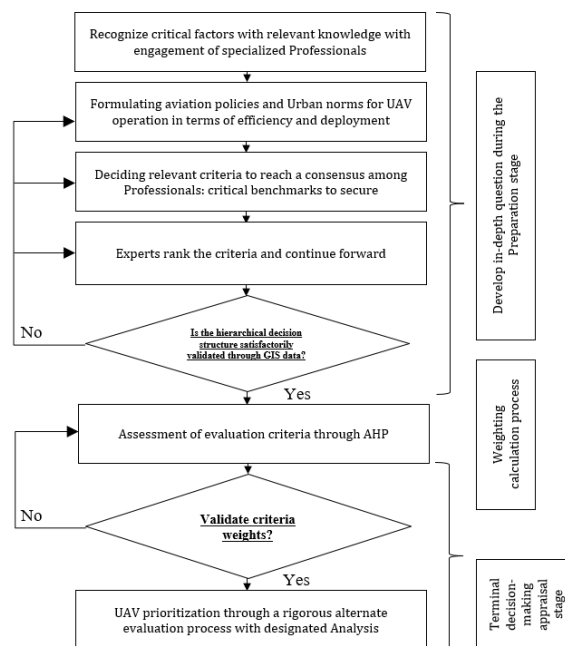


Figure 3. Hierarchical decision-making structure for UAS deployment in US Navy operations: three stages approach.

The **Preparation Phase** (Stage 1) involved framing research queries and gathering pertinent data on parameters such as 3D distance, signal intensity, interference levels, Radar Cross-Section (RCS), and jamming immunity; proven critical, this phase rated the X-47B UCAS's operational efficacy ranked on the USS George H.W. Bush (CVN-77) (Committee Air Force, 2014), including key activities such as catapult launch, recovery, emerging kinetic control techniques for hull feedback (Smith, N. et al., 2011), and wingtip folding, at peak performance with Computational Fluid Dynamics (CFD) and surrogate-based optimization (SBO), as evidenced in aerodynamic impacts and mechanical reliability (Wang, R. et al., 2022).

The **Weighting Calculation Process** (Stage 2) applied Geographic Information System (GIS) data and Multi-Criteria Decision Analysis (MCDA) to meticulously determine the relative significance of factors influencing the X-47B's operational effectiveness: accordingly, this MCDA method involved assigning exact weights to each input raster layer and summing each criterion, as statistically validated, to produce coherent and consistent output rasters.

As a result, the designated weights for the input layers were rated as follows: Hopping (1), Damage (1), Path Loss (2), Velocity (3), 3D Distance (4), No Savitsky-Golay Section 4 Unfiltered (5), and Savitsky Filter Applied (6). Each criterion was rigorously prepared and assigned its specific weight within the weighted sum tool in the ESRI® environment, ensuring exceptional levels of consistency and accuracy.

Within the scope of kernel trajectory analysis, the criterion with the Savitsky filter applied shows a subtle but significant influence, owing to its nuanced impact on the comprehensive analytical framework.

The **Decision-Making Appraisal Phase** (Stage 3) employed the Cramer-Rao Lower Bound (CRLB) and exponential smoothing to improve the accuracy and reliability of radar spatial data in detection probability (Yuan, C. et al., 2024). Defuzzification and consistent monitoring ensure data readiness and accuracy.

Steadily within this assessment framework, the iterated series of trajectories achieved high consistency, and unbiased estimators verified all criteria layers making comparisons with the 3D spatial representation of radar data visualising signal variations at critical points, refining error bounds through CRLB and exponential smoothing, random variability and enhanced measurement clarity in elevation angles, azimuth, and signal strength.

1.b. A three-stage preliminary context: objective from the Literature Review emerged

Making comparisons for predictive modelling during peacetime (Stone, P., 2022), Situational Awareness for ground systems, has incorporated laser-scanned data, InSAR, and rigorous GIS procedures for archaeological-historical site mapping (Bozzano, M. et al., 2024; Chetverikov, B., Hlotov, V., et al., 2024), also analyzing decibel Path Loss signals and morphological attributes extracted from the 10-meter resolution Digital Elevation Model (Tarquini, S. et al., 2017), vegetation health, and subsidence.

Contradicting the assumption that advanced technological systems are universally applicable for heritage site protection, the high cost and complexity of these advanced systems may limit their practical application in many heritage sites, particularly those in resource-limited settings. The adaptation of military-grade technology to civilian contexts may require significant modifications, introducing new vulnerabilities or operational challenges.

As evidenced by the archaeological zoning of Fire trenches in Bükk National Park (Hungary), the demonstration of advanced geospatial techniques indicates significant potential, albeit their practical implementation for EW protection remains uncertain (Juhász et al., 2016).

Notably, a noticeable trend has emerged in terms of countermeasure effectiveness, which is vital for sensor systems detecting real-time variable factors, as implied by Wu et al. (2024) and Zhang et al. (2022) by the same token for these anomalies, considered peacetime disruptors.

Lastly, and ancillary to the MCDA three-stage scope, the featuring of a 3D Active Electronically Scanned Array (AESA) subject to Electronic Attack (EA), e.g. frequency hopping and jamming resistance, has included morphological data operated by the Saab Giraffe 4A Radar System; the evaluation, albeit limited due to the focus on overall avionics trends and computational tests for Selinunte area park and designated as iterative research by the Department, employs multiple MCDA techniques to optimize the system.

1.b.I. Stage 1: overcoming static weighting assumptions in military operations

While these methodologies aim to enhance protection against EW threats, their alignment with the practical needs and resources of heritage site management remains a critical consideration.

In reverse, unlike the narrow focus of UCAVs, the UCAS system exemplifies a broader, more integrated network. By combining combat vehicles with advanced command and communication systems, UCAS offers a more comprehensive and adaptable operational framework.

The Weighting Calculation Process, integrating GIS in MCDA, aimed to enhance the X-47B's operational effectiveness but introduced rigidity by overlooking the dynamic nature of real-world environments. This inflexibility could lead to suboptimal decisions, as the process assumes weights remain constant under all

conditions. To counter this, the Savitsky-Golay filter was incorporated, providing a more flexible, adaptive approach to weighting (Selver, M. et al., 2018).

1.b.I.a Range estimation refinement in MCDA key criteria framework

To better contextualize the three-stage decision-making pipeline, integrating Command & Control airworthiness data from the electronic Consolidated Automated Support System (eCASS) highlights the necessity of incorporating the technological behaviour of AESA radar. By integrating the eCASS protocol, the Systems-Theoretic Process Analysis (STPA) aids in identifying potential hazards and mitigating risks in correspondence with the critical points.

The MCDA framework synergizes with STPA actions to detect critical points for UCAS operations, ensuring safety and reliability by analyzing potential failures and dangerous interactions. As visualized in Figure 4, key elements from the framework provide sequentially a detailed model of the control structure:

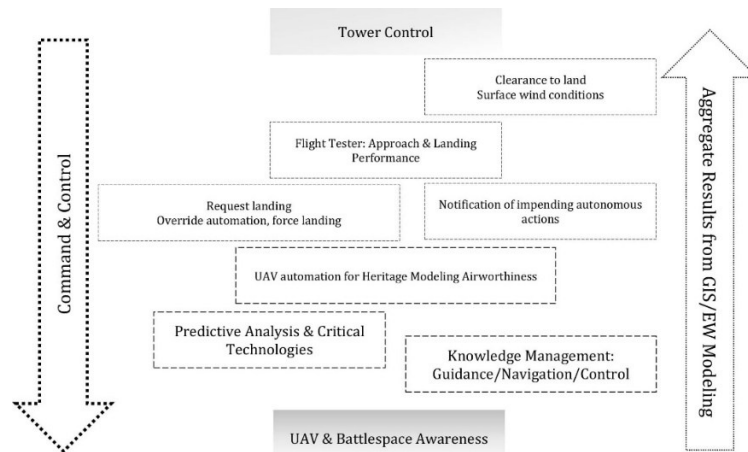


Figure 4. Applying MCDA methodologies to identify Key Criteria: eCASS and STPA.

The first stage involves Command & Control, which ensures that UCAS operations are effectively managed and coordinated. This includes Predictive Analysis & Critical Technologies, where data-driven insights and advanced technologies are used to anticipate and address potential issues. Knowledge Management encompasses Guidance/Navigation/Control, ensuring that all relevant information is accurately disseminated and utilized for optimal decision-making.

In the second stage, UCAS Automation for Heritage Modeling Airworthiness is crucial for maintaining operational safety and compliance with regulatory standards. This phase also includes Request Landing procedures, where automation can be overridden for forced landings if necessary. Flight Tester operations focus on Approach & Landing Performance, ensuring that UCAS lands safely under various conditions.

The third stage addresses the final clearance and notifications. Clearance to Land involves assessing surface wind conditions to ensure safe landing operations. Notification of Impending Autonomous Actions ensures that all relevant parties are aware of the UCAS's autonomous operations and any potential changes.

Throughout these phases, aggregate results from GIS/EW Modeling provide essential data and insights that inform and enhance the overall decision-making process.

1.b.II. Stage 2: research question aimed at the integration of input variables

To trigger the **Weighting Calculation Process**, a qualitative selection of appropriate technologies required careful consideration addressing the question: "How can multi-criteria decision analysis (MCDA) techniques can be translated in terms of mathematical information in terms of EW countermeasures for protecting cultural heritage sites?"

Subsequently, albeit not incorporated within the computational matrixes, as technologically incorporated in the UCAS system, the AESA radar participates in resource allocation via digital transmit/receive (T/R) modules with 360° scan coverage and data handling pipelines (Park, J. et al., 2021).

Visually, the sophisticated Digital Signal Processing (DSP) algorithms, including Fast Fourier Transform (FFT) and adaptive filtering, support the seamless operation of the UAS/UCAS in complex and contested environments, simultaneously, as clarified in Figure 5, with the highest rates of information processing; this underscores the clear need for scalable models.

Correspondingly, the **Decision-Making Appraisal Phase** aided the robustness of these systems in real-time data fusion and adaptive responses critically assessed by assigning input variables following the Consolidated

Automated Support System (eCASS) the Systems-Theoretic Process Analysis (STPA) by Rising, J., and Leveson N. (2018); in comparison, the Saab Giraffe 4A was noted for its ability to detect UCAS threats, notwithstanding limited to a specific frequency band.

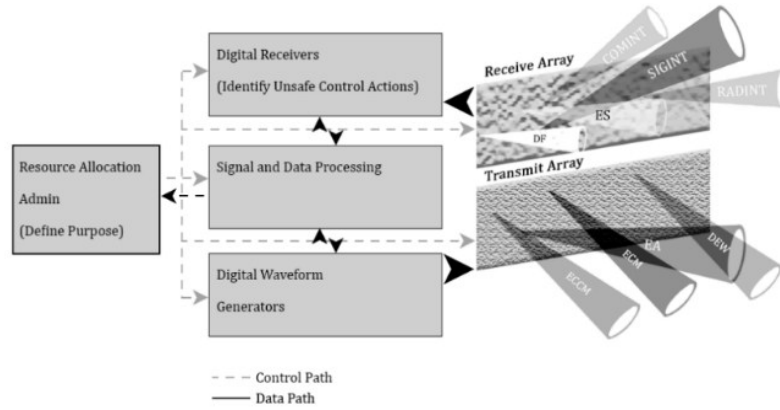


Figure 5. Conceptual framework Architecture of AESA. Inputs and Outputs.

1.b.II.a. Research question aimed at the integration of input variables

To benchmark this initial set, the review evaluated the effectiveness of various MCDA methods, embracing theoretical models by Zhang, and enhancing the Saab Giraffe 4A Radar System's performance in safeguarding cultural heritage sites from EW threats. Key features (A) include the Giraffe Radar System's feature matrix g_{ij} , representing specific capabilities or performance measures of the designated UCAS trajectory.

$$\mathbf{G} = \begin{bmatrix} g_{11} & g_{12} & g_{13} & g_{14} & g_{15} \\ g_{21} & g_{22} & g_{23} & g_{24} & g_{25} \\ g_{31} & g_{32} & g_{33} & g_{34} & g_{35} \end{bmatrix} \quad \text{(A). The matrix of input variables is organized column-wise from left to right and includes: i) 3D AESA Technology; ii) Frequency Hopping; iii) Advanced Algorithms; iv) Signal Processing and v) Interference Mitigation.}$$

- i) 3D AESA Technology (g_{11}) which provides enhanced detection and tracking of multiple targets with high accuracy and resolution exemplified by the following Volume integral:

$$g_{11} = \int_{x_1}^{x_2} \int_{y_1}^{y_2} \int_{z_1}^{z_2} \left(\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} \right) dx dy dz ; \text{(A.a)}$$

- ii) Frequency Hopping (g_{12}) which utilizes rapid changes in frequency to avoid detection and interception by adversarial jamming systems: $g_{12} = \sum_{i=1}^n f_i(t) \cdot \text{hop}(t_i) ; \text{(A.b)}$

- iii) Advanced algorithms (g_{13}) which incorporates algorithms to detect and counteract various forms of electronic interference: $g_{13} = FFT \left(\frac{1}{T} \int_0^T x(t) e^{-j2\pi f t} dt \right) ; \text{(A.c)}$

- iv) Signal processing (g_{14}) which uses robust signal processing techniques to filter out noise and maintain clear communication channels: $g_{14} = \mathbf{H}(s) = \frac{N(s)}{D(s)} ; \text{(A.d)}$

- v) Interference Mitigation (g_{15}) which actively identifies and mitigates interference from both intentional jammers and environmental noise: $g_{15} = \max_k \left(\frac{I_k}{J_k} \right) ; \text{(A.e)}$

1.b.III. Stage 3: Counter-Measure robust estimation

The adaptiveness of EW operations in estimating target range using Fast Fourier Transform (FFT) is considered in fault models (Zou, Y. et al., 2024). For each FID, the ground system computes variables from raw data, detailing the signal, including noise and transient spikes within the first UCAS sector, at a frequency of 0.18 GHz, ranging within 6.82 ± 5.84 .

Complementary to this, noise figure (NF) further layers of Counter-Measures, e.g., Man-in-The-Middle (MITM) and Denial-of-Service (DoS) (Liang, X., 2017) at the expenses of IoT-based battlefield units (Kovschavov, A. A., 2019), adopt transversely range estimation calculation (Ling, Q. et al., 2023) and noise level in the receiver.

Equation B also confirms the received signal S_i at frequency f_r :

$$S_i(f_r) = A_i a_r \left(\frac{f_r}{B}\right) \exp\left(-j\pi \frac{f_r^2}{\gamma}\right) \exp\left(-j2\pi f_r \frac{2R_i}{c}\right); \text{ Equation B (Ling, Q. et al., 2023).}$$

To calculate the range R_i to the target, with c , speed of light and t_i , the time delayed of the received signal, as shown in Equation C:

$$R_i = \frac{c \cdot t_i}{2}; \text{ Equation C (Ling, Q. et al., 2023).}$$

To establish the upper and lower bounds of the range estimation, we evaluate the components 6.82 and 5.84, derived from the frequency bandwidth and other system parameters, as evidenced in Equation C.a and C.b:

$$R_{upper} = \frac{c \cdot (6.82 + 5.84)}{2} = 1.899 \times 10^9 \text{ m}; R_{lower} = \frac{c \cdot (6.82 - 5.84)}{2} = 1.47 \times 10^8 \text{ m};$$

Equations C.a, C.b.

In accordance with the previous equations, we calculate the SINR, as a measure of signal quality, tailored to two Weighted versions: i) W. Signal Strength, as Strength of the received signal and ii) W. Noise Level, as Level of noise in the received signal, as outlined in Equation D:

$$\text{SINR}_{\text{weighted}} = \frac{(\text{Weighted Signal Strength})^2}{(\text{Weighted Signal Strength})^2 + 2 \times (\text{Weighted Noise Level})^2}; \text{ Equation D.}$$

To reinforce this monitoring aspect, we assume a robust and effective Fisher information, as presented in Equation E, to realistically accommodate our set of observation, and accommodate: R (range), θ_{el} (elevation angle), θ_{azi} (azimuth angle), A (amplitude) and N (noise); subscripts in the elements, such as $I_{R,\theta_{el}}$, $I_{A,\theta_{azi}}$, a relationship of covariance between the parameters is expressed:

$$\mathbf{I}(\theta) = \begin{pmatrix} I_R & I_{R,\theta_{el}} & I_{R,\theta_{azi}} & I_{R,A} & I_{R,N} \\ I_{\theta_{el},R} & I_{\theta_{el}} & I_{\theta_{el},\theta_{azi}} & I_{\theta_{el},A} & I_{\theta_{el},N} \\ I_{\theta_{azi},R} & I_{\theta_{azi},\theta_{el}} & I_{\theta_{azi}} & I_{\theta_{azi},A} & I_{\theta_{azi},N} \\ I_{A,R} & I_{A,\theta_{el}} & I_{A,\theta_{azi}} & I_A & I_{A,N} \\ I_{N,R} & I_{N,\theta_{el}} & I_{N,\theta_{azi}} & I_{N,A} & I_N \end{pmatrix};$$

$$I_R = \frac{2 \cdot \text{SNR} \cdot B \cdot T^2}{c^2} \quad \text{a)}$$

$$I_A = \frac{2 \cdot \text{SNR}}{c^2} \quad \text{b)}$$

$$\text{NF} = 10 \log\left(\frac{\text{SNR}_{in}}{\text{SNR}_{out}}\right) \text{ dB} \quad \text{c)}$$

Equation E. Fisher Matrix.

Equations E. a) b) c).

1.c.I. Scrutinizing eCASS: Key Factors in UCAS Performance

As indicated for the component 3D AESA Technology (θ_{11}), issues related to incorrect maintenance and aggregate results are critical. Contrasting to this incoherent raw data intercepted highlighted in Figure 6, we consider the disaggregation from the smoothing process targeting the first sector (Sector 1_V, highlighted in light green) utilizing Savitzky-Golay filtering, HRBFN_Output, and MP Output, spanning within the interval 6.82 ± 5.84 .

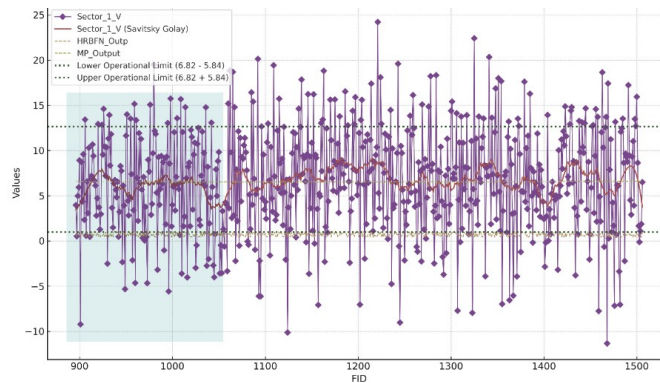


Figure 6. Detailed sector-by-sector monitoring of Savitzky-Golay Filter Performance Across All X-47B UCAS Sectors.

By the same token, the efficacy of the HRBFN (Heterogeneous Radial Basis Function Network), is highlighted, embracing a neural network model optimized for nonlinear function approximation and large dataset processing, integrating GHz frequency data, FID (Feature Importance Determination), and damage intensity metrics to deliver a comprehensive assessment of EW impacts on X-47B operations. On the other hand, the MP (Matching Pursuit) algorithm facilitates sparse signal representation, enhancing the robustness of data analysis in complex operational environments.

Nonetheless, this early critical assessment reveals potential pitfalls; in instance, the accuracy of the HRBFN model in real-time scenarios is crucial as we consider that the integration of GHz frequency data with FID and damage intensity metrics, while comprehensive, may encounter challenges related to data synchronization and processing speed.

Additionally, the MP algorithm's performance in sparse signal representation should be evaluated for potential limitations in handling high-noise environments and rapidly changing signal dynamics.

As evidenced in Figure 7, the comparative monitoring underscores the Savitsky Golay filter's capability to maintain signal integrity and operational reliability within sector 1 of the X-47B (EW features selection highlighted in light green) $f(t) = f_c + k_f \cdot m(t)$ (Proakis, J. and Salehi, M., 2007):

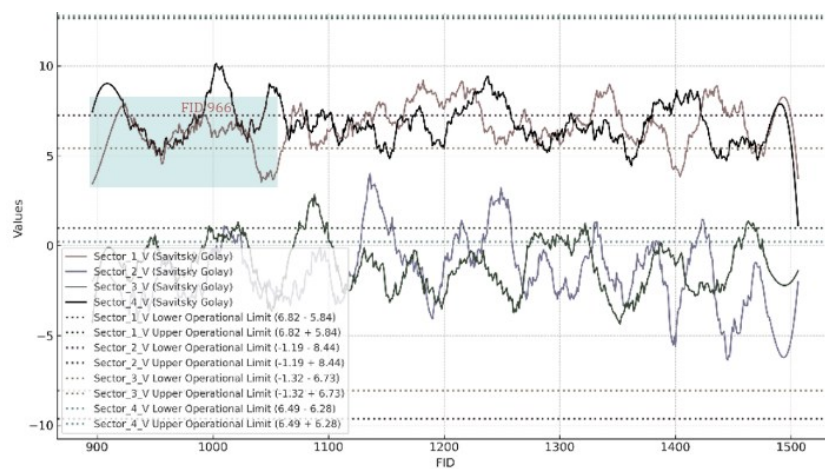


Figure 7. Savitsky Golay enhanced for Sector 1.

2. Materials and Methods

The materials derive from the corresponding manuals in terms of data, progressively simulated using advanced Python modelling modules such as NumPy, SciPy, Matplotlib, SimPy, PyDSTool, and TensorFlow, thus, selected for their capabilities in handling complex numerical operations, scientific computing, data visualization, discrete-event simulation, dynamical systems analysis, and machine learning, respectively including 3D active electronically scanned array (AESA), frequency hopping and section radar (Sijabat, P. et al., 2021), and sophisticated jamming resistance whose datasets are compatible with AHP-related models (Alharasees, O. et al., 2024, Chang, Da-Yong, 1996).

In the last instance, the computation allowed limited space for a Proximal Policy Optimization (PPO) algorithm (Ran, W. Et al., 2023) backed up by AESA thermal factors; this vision algorithms X-47B variables' allocation (Kong, X. et al., 2023, Belal A. et al., 2019) is benchmarked according to FID critical points across Path Loss GIS information in Selinunte area park, retrieved from previous departmental research (Polverino, S., 2024), thus strengthening its standing and authority internationally as an Institutional Chamber of Architects. This positions the department to play an active role in the transformation and defence of the historical Italian landscape in cooperation with the defence industry.

2.a. eCASS decision matrix

Fuzzy AHP handles distinctively uncertainty using fuzzy pairwise comparison matrices (Chen, Chen-Tung et al., 2006), computing fuzzy synthetic extent values, defuzzifying, normalizing weights, and calculating scores (Zadeh, A., 1965). BWM focuses on the most and least important criteria applied in stochastic MCDA models (Mohammadi, M. et al., 2020), solving an optimization problem to calculate composite scores. ELECTRE compares alternatives by constructing a decision matrix, assigning weights, calculating concordance and discordance indices, and ranking alternatives.

ANP extends AHP by considering interdependencies (Taherdoost, H. et al., 2023), forming and normalizing a supermatrix, and deriving composite scores from the limit supermatrix. Data for criteria like 3D Distance, Frequency Hopping (2-4 GHz), Signal Strength (40-100 dB), Interference Level (0-50 dB), Radar Cross-Section (0.01-10 m²), and Jamming Resistance (0-1) were normalized and analyzed using these MCDA methods. For example, a scenario with values $D = 3090.88$ meters, $F = 3.0976$ GHz, $S = 85.92$ dB, $I = 16.68$ dB, $RCS = 3.73$ m², and $JR = 0.2244$ yielded a composite damage score of 0.6683 using AHP.

3. Results overview of proposed frameworks

The tracking strategy proposed by Kennedy (2020, 2023) incorporates noise patterns also identified by Zhang et al. (2022), raw data, and Savitzky-Golay filtered values, enhanced in Figure 8. Specifically, statistical considerations from the resulting radar cross-section (RCS) data are statistically illustrated in Figure 9: most deviations are close to zero, with a minimum deviation of -7.21 m² and a maximum of 6.14 m²; in response, these preliminary results demonstrate that the Savitzky-Golay filter effectively smooths the original RCS data, preserving the primary structure while reducing noise.

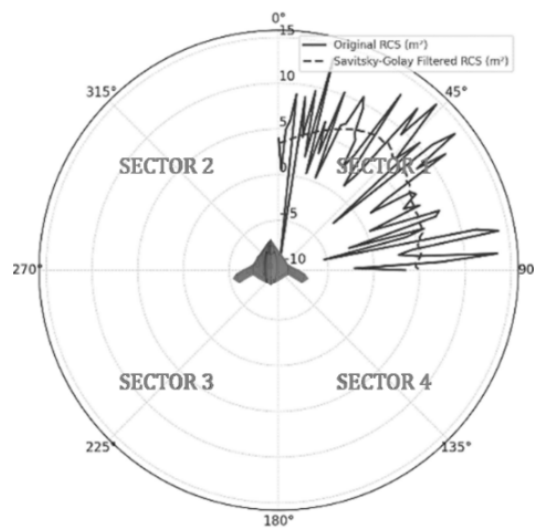


Figure 8. Radar Cross-Section. From a full 360-degree view, roughly a 1/4 section radar plot.

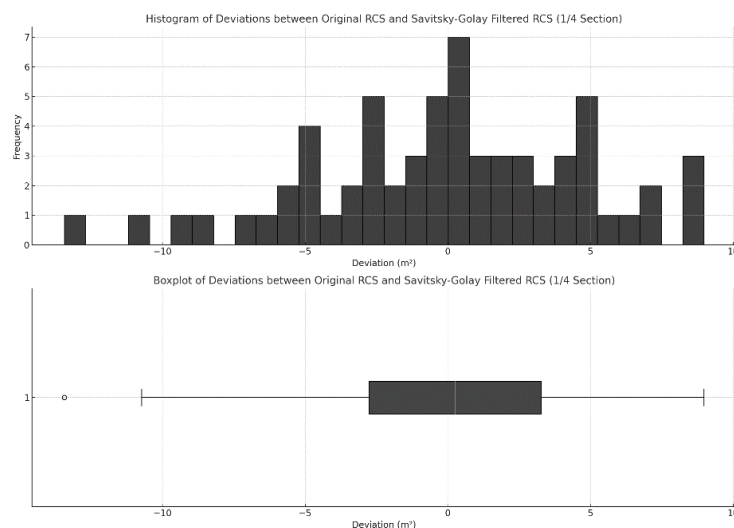


Figure 9. Mean deviation of -0.88 m² and a standard deviation of 3.03 m².

By evaluating the Radar Cross-Section (RCS) values for each measurement and analyzing the performance of three radar systems (*FID 896*, *FID 966*, *FID 1056*), the goal was to select the best radar system trajectory. This punctual assessment, based on the doctrine of critical points, involved detailed comparisons of 3D Distance, Frequency Hopping, Interference, RCS and Signal Strength, expressed in Table 1, ultimately determining the most suitable radar system for preserving the integrity of heritage sites against EW threats, concluding with a Technique for Order Preference by Similarity to Ideal Solution' (TOPSIS) evaluation, applied to select, sort, classify or label

alternatives for sorties (De Souza, L. et al., 2018) to determine oppositional aspects of the methods as indicated in Table 2:

Table 1. Sampled extracted information from the X-47B telemetry via Haversine formula, including critical points.

Critical Point	3D distance [mt]	Frequency Hopping [GHz]	Signal Strength (S) [dB]	Interference (I) [dB]	RCS [m2]	JR
FID 896	3090.88	3.0976	85.92	16.68	3.73	0.2244
FID 966	4120.56	2.8765	75.34	12.45	4.12	0.3345
FID 1056	2950.34	3.1234	88.45	20.56	2.56	0.1234

Table 2. Dichotomous overview of methods including: AHP, ANP, TFN, BWM, ELECTRE, and TOPSIS.

Method	3D distance [mt]	Frequency Hopping [GHz]	Signal Strength (S) [dB]	Interference (I) [dB]	RCS [m2]	JR
AHP	Y	Y	Y	N	N	N
ANP	Y	Y	Y	Y	Y	Y
TFN	Y	Y	Y	N	N	N
BWM	Y	Y	Y	N	N	N
ELECTRE	Y	Y	Y	Y	Y	Y
TOPSIS	Y	Y	Y	Y	Y	Y

3.a. Results from the Multi-MCDA evaluation

AHP methodology initiated the research so that for each criterion (C_1 - 3D Distance, C_2 - Frequency Hopping, C_3 - Signal Strength), pairwise comparisons of the alternatives (*FID 896*, *FID 966*, *FID 1056*) are conducted to form comparison matrices, which were then used to derive the priority vectors for evaluating the relative importance of each alternative with respect to the given criteria as exhibited from Equations 1-6:

$$A_C = \begin{bmatrix} 1 & 3 & 0.5 \\ 0.33 & 1 & 0.25 \\ 2 & 4 & 1 \end{bmatrix} ; \text{Equation 1.} \quad CR = \frac{CI}{RI} ; \text{Equation 2.} \quad CI = \frac{\lambda_{max} - n}{n - 1} ; \text{Equation 3.}$$

$$= \begin{bmatrix} 1 & 0.75 & 1.1 \\ 1.33 & 1 & 1.5 \\ 0.91 & 0.67 & 1 \end{bmatrix} ; \text{Equation 4.} \quad A_{C2} = \begin{bmatrix} 1 & 1.1 & 0.95 \\ 0.91 & 1 & 0.87 \\ 1.05 & 1.15 & 1 \end{bmatrix} ; \text{Equation 5.} \quad A_{C3} = \begin{bmatrix} 1 & 0.85 & 1.2 \\ 1.18 & 1 & 1.35 \\ 0.83 & 0.74 & 1 \end{bmatrix} ; \text{Equation 6.}$$

In matrix form, this can be represented as: $S = W_C \cdot [W_{C1} \ W_{C2} \ W_{C3}]$ is the vector of overall scores for the alternatives whereby W_{Cj} is the weight of criterion C_j , as proved in Equations 7-10.

$$W_C = \begin{bmatrix} 0.553 \\ 0.189 \\ 0.258 \end{bmatrix} ; \text{Equation 7.} \quad W_{A1} = \begin{bmatrix} 0.31 \\ 0.43 \\ 0.26 \end{bmatrix} ; \text{Equation 8.} \quad W_{A2} = \begin{bmatrix} 0.34 \\ 0.32 \\ 0.34 \end{bmatrix} ; \text{Equation 9.} \quad W_{A3} = \begin{bmatrix} 0.28 \\ 0.39 \\ 0.33 \end{bmatrix} ; \text{Equation 10.}$$

The best overall score $S(A_i) = \sum_{j=1}^n w_{Cj} \cdot w_{A_i}^{Cj}$ for alternative A_2 is calculated as 0.3892 (*FID 966*) while $S(A_1)$ (*FID 895*) and $S(A_3)$ (*FID 1056*) are separately 0.3293 and 0.2815.

A second method, ANP, initially involves structuring the decision problem as a network of clusters refined through a pairwise comparison (Equation 11): for each pairwise matrix, the priority vector is solved through the normalization of each eigenvector (Equation 12); given the priority weights from λ_{max} , each comprises elements that are interrelated, for instance, in evaluating radar systems (A_1, A_2, A_3) based on criteria such as 3D Distance (C_1), Frequency Hopping (C_2), and Signal Strength (C_3), the organization is subdivided into two clusters: Criteria and Alternatives, as substantiated by Equations 11-13:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} ; \text{Equation 11.} \quad A = \lambda_{max} W ; \text{Equation 12.} \quad W = \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1m} \\ W_{21} & W_{22} & \cdots & W_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ W_{m1} & W_{m2} & \cdots & W_{mm} \end{bmatrix} ; \text{Equation 13.}$$

Within each cluster and between clusters, pairwise comparisons are gauged to hold relative importance: these comparisons are quantified using a ratio scale, typically ranging from 1 (equal importance) to 9 (extreme

importance); the resulting pairwise comparison matrices A are structured such that each element a_{ij} represents the relative importance of element i over element j as for pairwise comparison matrix enhanced within the criteria cluster (Equations 14-16), i.e. for 3D distance (C_1), A_{A1} , Frequency Hopping (C_2), A_{A2} , Signal Strength (C_3), A_{A3} :

$$A_c = \begin{bmatrix} 1 & 3 & 0.5 \\ 0.33 & 1 & 0.25 \\ 2 & 4 & 1 \end{bmatrix} ; \text{ Equation 14.} \quad A_{A1}^* = \begin{bmatrix} 1 & 0.75 & 1.1 \\ 1.33 & 1 & 1.5 \\ 0.91 & 0.67 & 1 \end{bmatrix} ; \text{ Equation 15.} \quad A_{A2}^* = \begin{bmatrix} 1 & 1.1 & 0.95 \\ 0.91 & 1 & 0.87 \\ 1.05 & 1.15 & 1 \end{bmatrix} ; \text{ Equation 16.}$$

By normalizing W_c to obtain the priority weights for the criteria (corroborated in Equation 18), similarly, priority vectors from $A_c^* W = \lambda_{\max} w$, for the alternative matrices are computed (proven in Equations 17-21).

$$A_{A3}^* = \begin{bmatrix} 1 & 0.85 & 1.2 \\ 1.18 & 1 & 1.35 \\ 0.83 & 0.74 & 1 \end{bmatrix} ; \text{ Equation 17.} \quad W_c = \begin{bmatrix} 0.553 \\ 0.189 \\ 0.258 \end{bmatrix} ; \text{ Equation 18.} \quad W_{A1} = \begin{bmatrix} 0.31 \\ 0.43 \\ 0.26 \end{bmatrix} a) \quad W_{A2} = \begin{bmatrix} 0.34 \\ 0.32 \\ 0.34 \end{bmatrix} b) \quad W_{A3} = \begin{bmatrix} 0.28 \\ 0.39 \\ 0.33 \end{bmatrix} c)$$

$$W = \begin{bmatrix} W_{CC} & W_{CA} \\ W_{AC} & W_{AA} \end{bmatrix} ; \text{ Equation 19.} \quad W_{CC} = \begin{bmatrix} 0.553 & 0.189 & 0.258 \\ 0.189 & 0.189 & 0.258 \\ 0.258 & 0.189 & 0.258 \end{bmatrix} ; \text{ Equation 20.} \quad W_{CA} = \begin{bmatrix} 0.31 & 0.43 & 0.26 \\ 0.34 & 0.32 & 0.34 \\ 0.28 & 0.39 & 0.33 \end{bmatrix} ; \text{ Equation 21.}$$

The last step regarded the extraction of the weights for the alternatives from the limit supermatrix $W_\infty = \lim_{k \rightarrow \infty} W^k$ beforehand the conclusion with priority weights $w_\infty = [0.35 \quad 0.33 \quad 0.32]$. ANP method suggests that *FID* 896 (0.35) is the most preferred alternative, 966 (0.33) is the second preferred alternative while 1056 (0.32) is the least preferred alternative.

A third following method, fuzzy comparison matrices, uses linguistic terms converted (Zadeh, A. (1994) to triangular fuzzy numbers (TFN) $\tilde{A} = (l, m, u)$ (Sun, C., 2010) and ranked *FID* 896 (0.6683), *FID* 966 (0.6431), *FID* 1056 (0.6665), as substantiated in Equations 22-24 and framed in Table 3:

$$\tilde{S}_i = \left(\sum_{j=1}^n \tilde{a}_{ij} \right) \cdot \left(\sum_{i=1}^n \sum_{j=1}^n \tilde{a}_{ij} \right)^{-1} ; \text{ Equation 22.} \quad A = \frac{l + m + u}{3} ; \text{ Equation 23.} \quad w_i = \frac{A_i}{\sum_{i=1}^n A_i} ; \text{ Equation 24.}$$

Table 3. Composite Damage Score = $(w_1 \cdot N_1) + (w_2 \cdot N_2) + \dots + (w_n \cdot N_n)$.

Criteria	D	F	S	I	RCS	JR
D	(1, 1, 1)	(1/3, 1/2, 1)	(1/2, 1, 3/2)	(1/2, 1, 3/2)	(1/3, 1/2, 1)	(1, 2, 3)
F	(1, 2, 3)	(1, 1, 1)	(1/2, 1, 3/2)	(1/3, 1/2, 1)	(1/2, 1, 3/2)	(1, 2, 3)
S	(2/3, 1, 3/2)	(2/3, 1, 3/2)	(1, 1, 1)	(1/3, 1/2, 1)	(1/2, 1, 3/2)	(1, 2, 3)
I	(2/3, 1, 3/2)	(1, 2, 3)	(1, 2, 3)	(1, 1, 1)	(1/3, 1/2, 1)	(1, 2, 3)
RCS	(1, 2, 3)	(2/3, 1, 3/2)	(2/3, 1, 3/2)	(1, 2, 3)	(1, 1, 1)	(1, 2, 3)
JR	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 1)

A fourth evaluation, based on Best-Worst Method (BWM), was likewise applied to evaluate the effectiveness of the EW system for three different scenarios: *FID* 896, *FID* 966, and *FID* 1056 as set of n criteria for the maximum absolute difference to be minimized (established in Equation 25) subject to weight of the best, and then worst, criterion (outlined in Equation 25); ensuring that the weights are normalized with a total distribution among all criteria equal to 1 (or 100%) (as confirmed in Equation 26) and non-negatives (Equation 27) hence guaranteeing validity and consistency:

$$\min_{\xi, w_i} \xi ; \text{ Equation 25.} \quad \begin{cases} |w_B - a_{Bj} \cdot w_j| \leq \xi \forall j \\ |w_j - a_{jW} \cdot w_W| \leq \xi \forall j \end{cases} ; \text{ Equation 26.} \quad \sum_{i=1}^n w_i = 1 \quad w_i \geq 0 \forall i ; \text{ Equation 27.}$$

From the current literature, the method involves determining the most and least important criteria and then comparing these criteria against all others; for this analysis, the criteria considered were 3D Distance (C_1), Frequency Hopping (C_2), and Signal Strength (C_3); the 3D Distance (C_1) was identified as the most important criterion, and Signal Strength (C_3) as the least important.

The pairwise comparison vectors were established: the Best-to-Others vector (BO) with values, $a_{B1} = 1$, $a_{B2} = 4$, $a_{B3} = 6$, and the Others-to-Worst vector (OW) with values $a_{1W} = 6$, $a_{2W} = 3$, and $a_{3W} = 1$. These vectors formed the basis of the optimization problem to determine the weights for each criterion (w_1 for C_1 , w_2 for C_2 , and w_3 for C_3).

After solving the optimization problem, the weights obtained were $w_1 = 0.5$, $w_2 = 0.3$, and $w_3 = 0.2$. The normalized values for each criterion were multiplied by their respective weights and summed to obtain the overall score N_1 (0.4773), N_2 (0.7744) and N_3 (0.8592); furthermore, these weights were then used to calculate the composite damage scores for each *FID*: 896 (0.6187), 966 (0.5899), 1056 (0.6441).

A fifth method named ELECTRE, (ELimination Et Choix Traduisant la REalité), is applied to evaluate the effectiveness of the EW system for *FID* 896, *FID* 966, and *FID* 1056 based on criteria such as 3D Distance (C_1), Frequency Hopping (C_2), and Signal Strength (C_3). First, the decision matrix A is constructed with constructed values (seen in Equation 28), and afterwards normalized (also shown in Equation 29) resulting in: w_1 , w_2 and w_3 , respectively 0.3, 0.25 and 0.45:

$$A = \begin{bmatrix} 3090.88 & 3.0976 & 85.92 \\ 4120.56 & 2.8765 & 75.34 \\ 2950.34 & 3.1234 & 88.45 \end{bmatrix} ; \text{ Equation 28.} \quad A_{norm} = \begin{bmatrix} 0.7501 & 0.9917 & 0.9714 \\ 1.000 & 0.9209 & 0.8518 \\ 0.7161 & 1.0000 & 1.0000 \end{bmatrix} ; \text{ Equation 29.}$$

The concordance matrix C , indicating the degree to which one alternative is at least as good as another, is computed using C_{ij} where S_{ij} is the set of criteria where alternative i is better than or equal to alternative j .

Concordance Matrix ($C = 0.55$), which shows the degree to which one alternative is at least as good as another, the Discordance Matrix ($D = 0.0548$), which highlights the degree to which one alternative is strictly worse than another, and the Outranking Matrix, which integrates the concordance and discordance relationships to rank the alternatives, ultimately indicating that *FID* 896 is the most preferred alternative, followed by *FID* 966 and *FID* 1056 as presented in Equations 30 and 31:

$$A_{weighted} = \begin{bmatrix} 0.2250 & 0.2479 & 0.4371 \\ 0.3000 & 0.2302 & 0.3833 \\ 0.2148 & 0.2500 & 0.4500 \end{bmatrix} ; \text{ Equation 30.} \quad C_{ij} = \frac{\sum_{k \in S_{ij}} w_k}{\sum_{k=1}^n w_k} ; \text{ Equation 31.}$$

3.b. TOPSIS ranking of effectiveness

In the last instance, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was considered: the decision matrix included criteria such as 3D Distance (C_1), Frequency Hopping (C_2), Signal Strength (C_3), Interference Level (C_4), RCS (C_5), Jamming Resistance (C_6), and Number of Frequency Hopping (C_7).

By normalizing the decision matrix and applying equal weights to each criterion, we determined the ideal and negative-ideal solutions. Calculating the separation measures and relative closeness to the ideal solution, we found that *FID* 966 (A_2) ranked highest, followed by *FID* 1056 (A_3), and finally *FID* 896 (A_1). This ranking reflects the effectiveness of each radar system across all evaluated criteria, as evidenced in the following Table 4, quantitatively allocated in Equation 32 and gradually computed from Equations 33 to 41:

Table 4. TOPSIS criteria and outcomes.

Criteria	<i>FID</i> 896	<i>FID</i> 966	<i>FID</i> 1056
3D Distance (m)	3090.88	4120.56	2950.34
Frequency Hopping (GHz)	3.0976	2.8765	3.1234
Signal Strength (dB)	85.92	75.34	88.45
Interference Level (dB)	16.68	12.45	20.56
RCS (m ²)	3.73	4.12	2.56
Jamming Resistance (unitless)	0.2244	0.3345	0.1234
Number of Frequency Hopping	1000	1500	2000

$$D = \begin{bmatrix} 3090.88 & 3.0976 & 85.92 & 16.68 & 3.73 & 0.2244 & 1000 \\ 4120.56 & 2.8765 & 75.34 & 12.45 & 4.12 & 0.3345 & 1500 \\ 2950.34 & 3.1234 & 88.45 & 20.56 & 2.56 & 0.1234 & 2000 \end{bmatrix}$$

Equation 32. Decision Matrix.

$$C_1 = \sqrt{3090.88^2 + 4120.56^2 + 2950.34^2} = \sqrt{9554450.57 + 16988094.31 + 8704504.11} = \sqrt{35247049} = 5936.61$$

Equation 33 3D Distance (C_1).

$$r_{11} = \frac{3090.88}{5936.61} = 0.5205 ; r_{21} = \frac{4120.56}{5936.61} = 0.6942 ; r_{31} = \frac{2950.34}{5936.61} = 0.4970$$

Equation 34. Normalized values for $C1$.

$$R = \begin{bmatrix} 0.5205 & 0.5651 & 0.5981 & 0.5612 & 0.5530 & 0.5156 & 0.3578 \\ 0.6942 & 0.5250 & 0.5248 & 0.4192 & 0.6112 & 0.7693 & 0.5367 \\ 0.4970 & 0.5693 & 0.6166 & 0.6916 & 0.3797 & 0.2838 & 0.7156 \end{bmatrix}$$

Equation 35. Normalized Decision Matrix R .

$$V = \begin{bmatrix} 0.0744 & 0.0807 & 0.0854 & 0.0802 & 0.0790 & 0.0737 & 0.0511 \\ 0.0992 & 0.0750 & 0.0749 & 0.0599 & 0.0873 & 0.1099 & 0.0767 \\ 0.0710 & 0.0813 & 0.0881 & 0.0988 & 0.0542 & 0.0406 & 0.1022 \end{bmatrix}$$

Equation 36. Assumed equal weights for simplicity: $w = \frac{1}{7} \approx 0.1429$.

$$V^+ = (\max v_{ij}) = (0.0992, \quad 0.0813, \quad 0.0881, \quad 0.0988, \quad 0.0873, \quad 0.1099, \quad 0.1022)$$

$$V^- = (\min v_{ij}) = (0.0710, \quad 0.0750, \quad 0.0749, \quad 0.0599, \quad 0.0542, \quad 0.0406, \quad 0.0511)$$

Equation 37. Ideal and Negative-Ideal Solutions.

$$S^+ = \sqrt{(0.0744 - 0.0992)^2 + (0.0807 - 0.0813)^2 + \dots + (0.0511 - 0.1022)^2} = 0.0707$$

$$S^- = \sqrt{(0.0744 - 0.0710)^2 + (0.0807 - 0.0750)^2 + \dots + (0.0511 - 0.0511)^2} = 0.0252$$

Equation 38. Separation Measures.

$$C_1^* = \frac{S_1^-}{S_1^+ + S_1^-} = \frac{0.0252}{0.0707 + 0.0252} = 0.2625$$

Equation 39. Relative Closeness to the Ideal Solution & Ranking the Alternatives (*).

$$C_2^* = \frac{S_2^-}{S_2^+ + S_2^-} = \frac{0.0531}{0.1022 + 0.0531} = 0.3424$$

Equation. 40. Relative Closeness to the Ideal Solution & Ranking the Alternatives (*).

$$C_3^* = \frac{S_3^-}{S_3^+ + S_3^-} = \frac{0.0734}{0.1421 + 0.0734} = 0.3407$$

Equation 41. Relative Closeness to the Ideal Solution & Ranking the Alternatives (*).

3.c. TOPSIS' considerations from scaled factors

This TOPSIS refinement indicated that *FID* 966 (Alternative A_2) is the most preferred radar system, value 0.3424 followed closely by *FID* 1056, value 0.3407, (Alternative A_3), and lastly *FID* 896, value 0.2625, (Alternative A_1): this ranking reflects the relative closeness of each alternative to the ideal solution, effectively capturing the performance across all evaluated criteria as specified in Table 5:

Table 5. Benchmarking of critical points in the designated ground deterrence system.

Critical Point [FID]	3D distance [mt]	Frequency Hopping [MHz]	Signal Strength (S) [dB]	Interference (I) [dB]	RCS [m2]	JR [dB/m2]	g_{11} [mt]	g_{12} [MHz]	g_{13} [dB]	g_{14} [null]	g_{15} [dB/m2]
896	3090.88	30976	85.92	16.68	3.73	0.2244	309.088	30976	0.8592	0.191	4.472
966	4120.56	28765	75.34	12.45	4.12	0.3345	412.056	28765	0.7534	0.164	3.022
1056	2950.34	31234	88.45	20.56	2.56	0.1234	295.034	31234	0.8845	0.229	8.031

To thoroughly evaluate the Radar System's performance of the ground EW truck, five AESA-based measurements have been calculated accordingly to (A) set of Equations sorting out the X-47B scratches of information (referring to **Table 1**): g_{11} , the 3D distance scaled by a factor, measured in meters (mt). For FID 896, 966, and 1056, the values are 309.088 mt, 412.056 mt, and 295.034 mt, respectively.

Correspondingly, these distances highlight the spatial dimensions critical for radar operations, yet the scaling factor used is arbitrary and may require further justification in future activities of the department; g_{12} , representing frequency hopping, with values 30976 MHz for FID 896, 28765 MHz for FID 966, and 31234 MHz for FID 1056. This indicates the system's ability to switch frequencies rapidly, enhancing jamming resistance. Nonetheless, the assumption that the hopping function is consistent and in future, the research may oversimplify real-world scenarios; g_{13} , as parameter scales for the signal strength, with values are 0.8592 dB, 0.7534 dB, and 0.8845 dB for FID 896, 966, and 1056, respectively.

At this point, the scaling factor (0.01) should be critically assessed for relevance and accuracy; g_{14} , as the dimensionless parameter, more clearly, the ratio of interference to signal strength plus one.

The values, 0.191, 0.164, and 0.229 for FID 896, 966, and 1056, respectively, assume that this ratio assesses the impact of interference relative to signal strength, highlighting the radar system's resilience.

The formula used is straightforward but may need refinement to account for more complex interference dynamics with a comparative quality scale of satisfaction; g_{15} , representing the ratio of interference to radar cross-section: for FID 896, 966, and 1056, the values are 4.472 dB/m², 3.022 dB/m², and 8.031 dB/m², respectively. This metric underscores the effectiveness of interference mitigation relative to the target's radar cross-section, though the linear relationship assumed might not capture nonlinear interactions in actual conditions; **JR**, indicating the effectiveness of jamming relative to the radar cross-section. Notwithstanding, the precise JR values highlight the relative jamming effectiveness but need to be contextualized within the operational environment for a holistic assessment as further explained.

3.d.I. Telemetry data and ECM results

The weighted sum integrates factors for three critical points into a single output, balancing and reflecting each factor's relative importance across the truck position, shown as Alpha starting from Figure 10 and the X-47B trajectory, which heads west before turning back east. Initially, these sensed UCAS data were abstracted as part of the Change of Loss during training and paired with the Change of Reward (Ran, W. et al., 2023) for aerial optimization (Pan, Nan, M., 2021). This process was benchmarked in terms of velocity updates and determined Final Global Best Position (*) and Final Global Best Score (**) here quantitatively listed in Table 6 and henceforth visualized in GIS mapping, from Figure 10 to Figure 16.

Table 6. FIDs and intermediate thresholds: Temperature (Kelvin).

FID	UCAS Temperature Sensed	Number of Iterations	Target Algorithm (PSO)
FID 896	288.15	84.550283	-
	437.55	84.5506	- 8.56112687 × 10 ⁻¹² * 8.39323714 × 10 ⁻²⁷ **
FID 966	513.15	84.551050	-
	480.28	102.00	1.95376808 × 10 ⁻¹⁰ * 1.9565764 × 10 ⁻²³ **
FID 1056	420.00	84.55104976	-

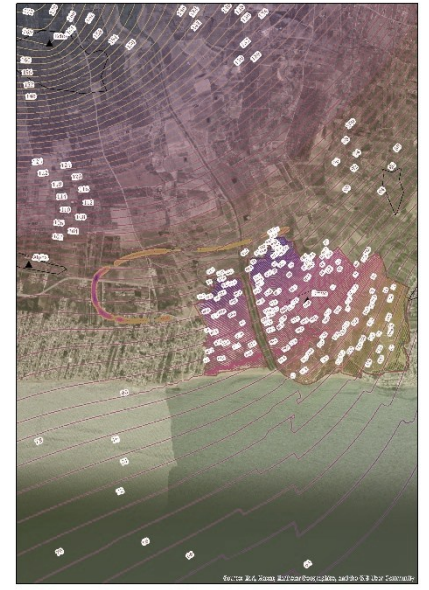
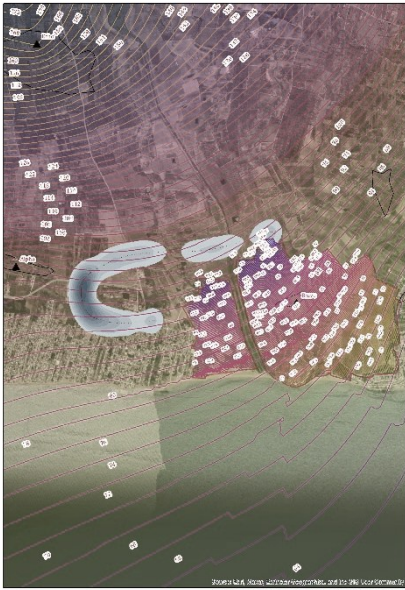


Figure 10. Path Loss Measurement Accuracy at 99.43 %, illustrating signal attenuation over varying distances.
Figure 11. Path Loss Measurement Accuracy at 99.76 %, emphasizing changes in velocity during trajectory turns.
Figure 12. Frequency Hopping Effectiveness at 99.89 %, showcasing the adaptive frequency agility.

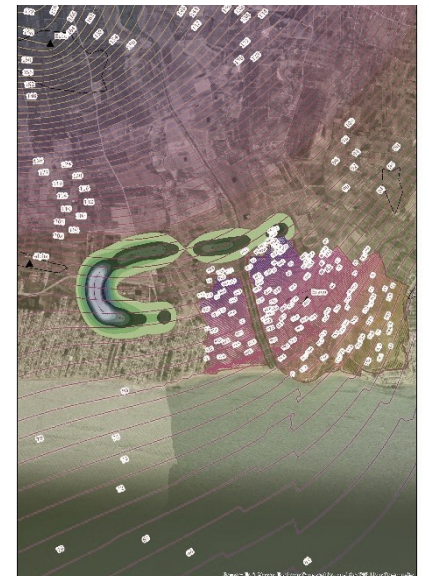
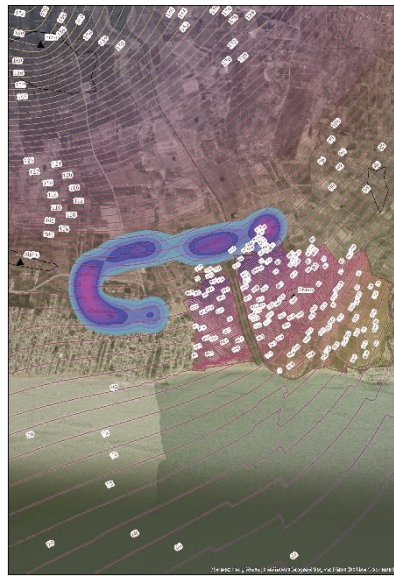
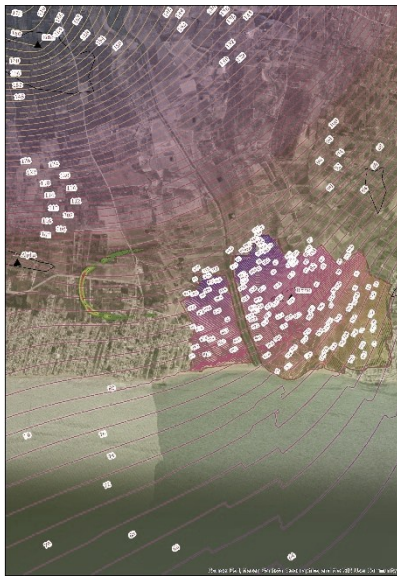


Figure 13. Critical UCAS Telemetry Data Analysis at 99.94 %.
Figure 14. 3d Distance accuracy at 90.07 %.
Figure 15. RCS 99.17 % and Savitzky-Golay 99.67 %.

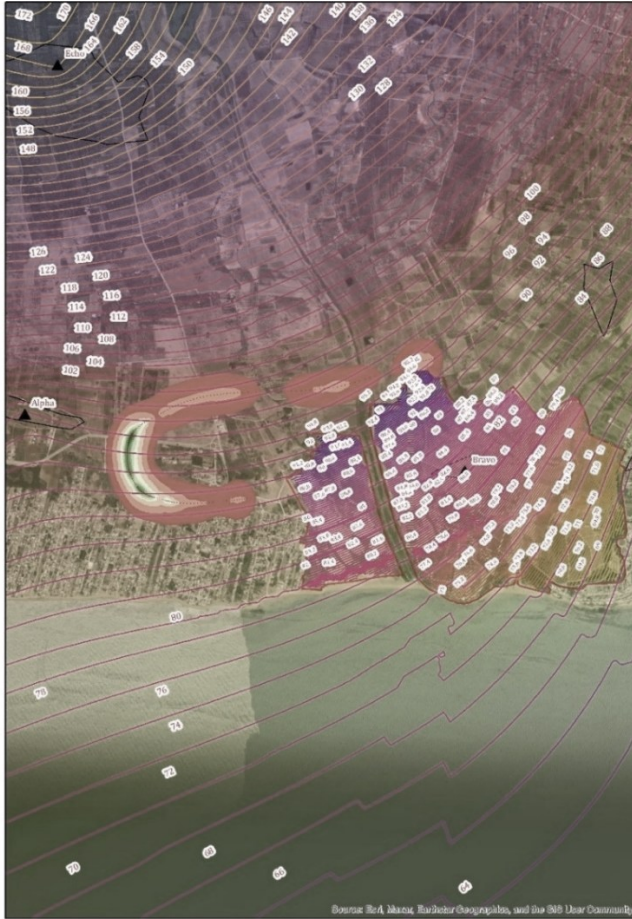


Figure 16. Weighted Sum 99.42% (Saaty T., 1988) emphasizes the significance of the PP for 7 drivers in **Equations 42.**

The weighted sum process involved multiplying each input raster layer by its corresponding weight and summing the results to produce an output raster: i) Hopping (Weight: 1); ii) Damage (Weight: 1); iii) Path Loss (Weight: 2); Velocity (Weight: 3); 3D Distance (Weight: 4); No Savitsky-Golay Section 4 Unfiltered (Weight: 5); Savitsky Filter Applied (Weight: 6).

Each criterion was carefully prepared and assigned its respective weight in the weighted sum tool within ESRI® suite. Also ensuring all raster layers were in the same coordinate system with matching cell sizes and extents is crucial for maintaining consistency and accuracy.

For kernel trajectory analysis X-47B, the Savitsky filter applied criterion holds a weak significant influence due to its refined impact on the analysis, as confirmed in Figure 17:

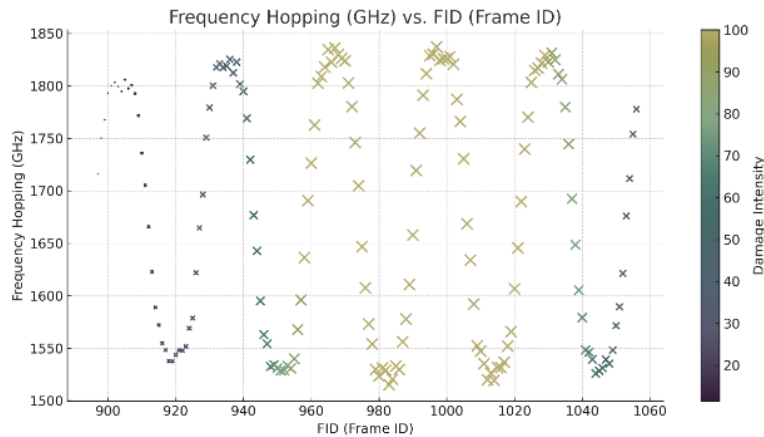


Figure 17. Profiling of X-47B damage against FIDs.

Charting trends and patterns, the profiling of UCAS Damage against Frame Identifiers (FID), we are able to observe its enhanced the statistical correlation between three frame identifiers and quantified damage intensity in the following Figure 18:

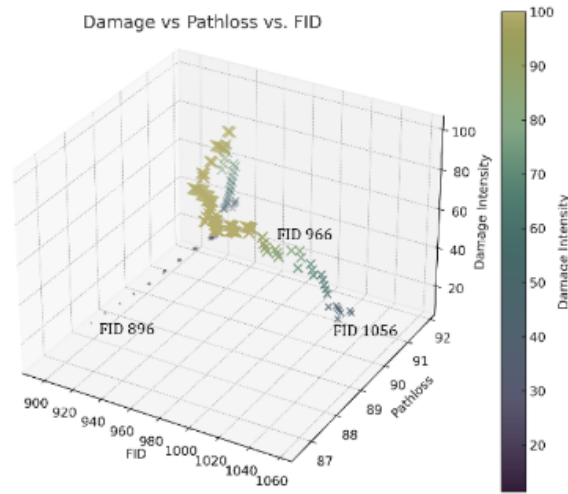


Figure 18. Profiling of X-47B damage against FIDs.

To demonstrate the variation in damage intensity as influenced by Path Loss effects across different frames. In Figure 19, the debriefing of 3D Damage in Electronic Countermeasure (ECM), provides a comprehensive visualization of damage intensity in relation to frequency hopping and frame identifiers in a three-dimensional space:

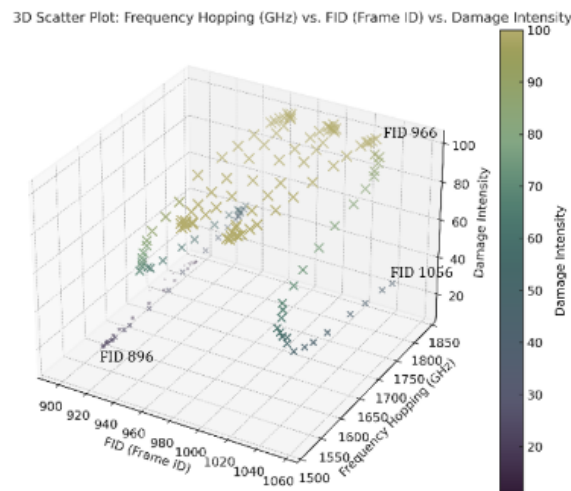


Figure 19. Path Loss Enhancement of X-47B Damage Signatures.

3.d.II. Particle Swarm Optimization

Proportionately, another critical aspect of this three-dimensional analysis is the Primary Path (PP) which is confirmed within the Consolidated Automated Support System (eCASS) for UCAS systems, along with the Systems-Theoretic Process Analysis (STPA) approach by Rising and Leveson (2018). For each FIDs, seeing 84 iterations, we adopted the Particle Swarm Optimization (PSO) method algorithm defined by its simplicity and efficiency in optimizing nonlinear functions, leveraging the social behavior of points aggregations to find optimal solutions employing the following calculation.

Explaining specifics, to solve its overall behaviour by the collective movement of multiple critical points, establishing velocity ($v_i(t)$) and position ($x_i(t)$), dynamically updated based on the inertia weight (ω), cognitive coefficient (c_1), social coefficient (c_2), and random coefficients (r_1 and r_2).

In our PSO, each potential solution to the optimization problem is represented as a “particle” as confirmed by authors Kennedy and Eberhart in their seminal 1995 paper so that two additional parameters were accounted: ϕ_1 and ϕ_2 , cognitive and social, both set to 2.0 as stated in Equation 43(a).

$$v_i(t+1) = v_i(t) + \phi_1 \times (p_i(t) - x_i(t)) + \phi_2 \times (g(t) - x_i(t)) ; \text{Equation 43.}$$

$$\text{Where } x_i(t+1) = x_i(t) + v_i(t+1) ; \text{Equation 43.a.}$$

Relative to its $v_i(t)$ and $x_i(t)$, respectively velocity and position data of particle i at iteration t , we present for our critical points, as listed in Table 7:

Table 7. PSO for critical points.

	FID 896	FID 966	FID 1056
$v_i(t)$	0.097	0.687	3.787
$x_i(t)$	905.488	902.197	905.984
ω	0.5	0.6	0.7
c_1	1.5	1.3	1.1
c_2	1.5	1.3	1.1
r_1	0.7	0.5	0.6
r_2	0.3	0.4	0.2

As evidenced by author Kaveh, Ali. in 2021, we present the results in Table 7, whereby the PSO method involved resetting a portion of the particles to new, random positions at regular intervals, thus ensuring that the swarm does not converge prematurely and maintains diversity f as expressed in Equation 44:

$$v_i(t+1) = \omega v_i(t) + c_1 r_1 (p_i(t) - x_i(t)) + c_2 r_2 (g(t) - x_i(t)) + c_3 r_3 \frac{T}{W} ; \text{Equation 44.}$$

A noticeable trend evidenced by Eberhart and Yuhui Shi. (2001), is its impact on the global best position, specifically of the periodic reset mechanism, 1(*) and 2(**), allocating the variable c_3 , contributing to a novel domain-specific influence in terms of thrust factor also assuming as $T/\dot{W}$ for engine efficiency, as detailed in Table 8:

Table 8. Temperature values retrieved from the PSO evaluation.

	FID 896	FID 966	FID 1056
Temperature	400.0	1550.0	1500.0
$p_i(t)^*$	1364.280	1279.257	1500.0
$g(t)^{**}$	1600.0	1600.0	1600.0

3.d.III. PSO and Thrust adaptation

To contextualize the analysis of the relationship between entropy and temperature in the provided images, we expose the thrust-to-weight (T/W) ratio, a critical parameter in evaluating the performance of aircraft engines for the designated trajectory. This analysis, grounded in the performance characteristics of the Pratt & Whitney F100 jet engine, offers insights into engine efficiency and optimization, as detailed in the provided images and supported by the referenced paper by Prisacariu and Ciubotaru (2017).

Demonstrating the grounded performance of Pratt & Whitney F100 implemented in the designated UCAS X-47B, we detail in Figure 20, the supported referenced technical benchmark presented by Prisacariu and Ciubotaru in 2017 (“Henri Coandă” Air Force Academy of Braşov, Romania), albeit tailoring lowest infrared signatures consistent with stealth mode at low subsonic speeds (Krivoshchapov, A., 2019) which are appropriate for take-off along the coastal scenario of Selinunte:

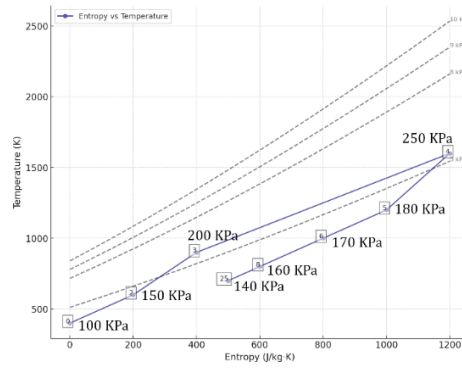


Figure 20. Correlation between entropy ($J/kg \cdot K$) and Temperature (K) across pressure levels (KPa).

Specifically, the polyline shows a general trend of increasing temperature with increasing entropy, indicating that higher entropy states correspond to higher temperatures within the system. This trend is consistent with the thermodynamic principles outlined by Prisacariu and Ciubotaru.

Accordingly, lower initial temperatures are retrieved from Figure 21, indicating a significant reset to a higher entropy state, leading unequivocally to a potential increase in energy or efficiency of the specific thrust (T_{sp}); as continued in Figure 22, the y-axis of the provided graph indicates the fitness values, which range from 0 to 100, color-coded from purple (low fitness) to red (high fitness), each of them representing the performance metric used in the Particle Swarm Optimization (PSO) algorithm, with higher values indicating better performance or more optimal solutions. Each icon is proportional to iteration numbers.

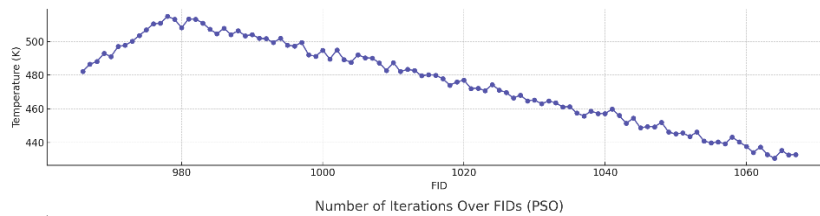


Figure 21. X-47B temperatures sensed over FIDs.

By the same token, the second image, Figure 22, provides analytical data for three FIDs: 896, 966, and 1056, (respectively 1364.280 K, 1550 K and 1279.257 K) indicating: i) along the y-axis the fitness values, which range from 0 to 100 - from purple (low fitness) to red (high fitness) - in increments of 20: each of them represents the performance metric used in the Particle Swarm Optimization (PSO) algorithm, with higher values indicating better performance or more optimal solutions.

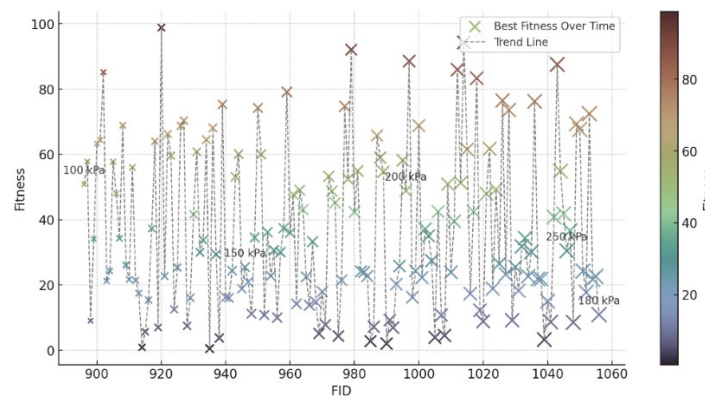


Figure 22. PSO optimization with performance values of T/W across different pressure conditions.

Nonetheless, the initial conditions, denoted as FID 896, exhibit certain limitations. The parameters include an inertia weight w of 0.5, a cognitive coefficient c_1 of 1.5, a social coefficient c_2 of 1.5, an initial velocity $v_i(t)$ of 0.097, a personal best position p_i of 1364.280, a current position ($x_i(t)$) of 905.488, and a global best position g of 1600.0. The computed subsequent velocity $v_i(t)$ is 0.472. The results match with Reward and Improvement Random Factors over iteration evaluating results of r_1 and r_2 , of respectively 0.7 and 0.3.

The reward across PSOs and over iterations shows significant initial fluctuations but stabilizes as the algorithm converges towards an optimal solution. The matrix operations update the velocity vector, and the reward values indicate improvement in the objective function. Initially, these values fluctuate due to dynamic adjustments made by the PSO algorithm to find better solutions; the reward values progressively decrease, reflecting the convergence of the PSO algorithm towards the optimal resolution.

Regarding the UAV velocities, for FID 896 the velocity is 50.0 km/h, for FID 966 the velocity is 54.59 km/h, and for FID 1056 the exit velocity is 53.22 km/h.

3.d.IV. AESA vulnerability: T/R-module in heat transfer disruption

While these PSOs parameters provide a theoretically robust starting point, they may yet require considering the intrinsic complexity and variability of inherent AESA electronics, as well as the completeness of this methodology review.

To replicate the power performance graph of a GaN T/R-module front-end at 11 GHz, plotted in Figure 23, occurred within Loss-Reward Random Factors, the input power range was defined from 0 to 20 dBm and approximated the corresponding output power, gain, and PAE values using logarithmic functions based on visual data from the original graph.

The output power was calculated using the function $25 + 20 \times \log_{10}(\text{input power} + 1)$, while the gain was determined with $5 + 15 \times \log_{10}(\text{input power} + 1)$.

The Power Added Efficiency (PAE) was estimated as $5 + \frac{19 \times \log_{10}(\text{input power} + 1)}{\text{input power} + 1}$; in addition, using these functions, the graph with input power, on the x-axis, and the calculated values for output power, gain, and PAE on the y-axis have been computed and plotted. The resulting benchmark provided a clear representation of how the output power, gain, and PAE varied with input power, accurately reflecting the performance characteristics of the GaN T/R-module in contrast to the jamming.

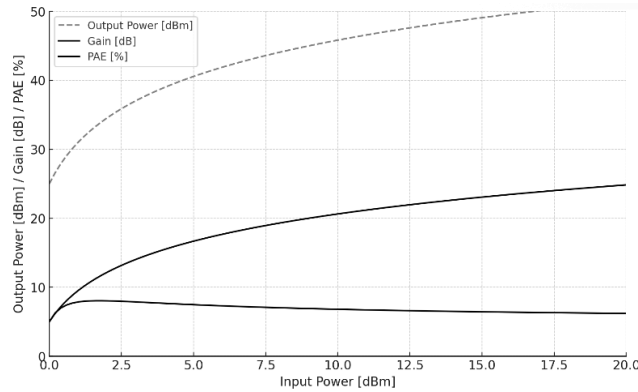


Figure 23. GaN T/R module front-end at 11 GHz.

The results in Equation 44 illustrate how the Rayleigh number (Ra) varies with the characteristic length (L) of the T/R module, providing both a visual and interpretative summary: i) the X-axis represents the characteristic length in meters, ranging from 2 mm to 10 mm, while ii) the Y-axis denotes the Rayleigh number, a crucial measure of natural convection in the system. As the characteristic length increases, the Rayleigh number rises exponentially, indicating that larger T/R modules promote greater natural convection and enhance heat transfer.

$$Ra_{al} = \frac{g\beta (T_s - T_{infinite})L^3 Pr}{\nu^2} \quad ; \quad \text{Equation 44.}$$

Assuming typical values: $g = 9.81 \text{ m/s}^2$, $\beta = 2.1 \times 10^{-4} \text{ K}^{-1}$, $T_s - T_{infinite} = 50 \text{ K}$, $L = 0.1 \text{ m}$, $Pr = 0.71$, and $\nu = 1.5 \times 10^{-5} \text{ m}^2/\text{s}$, the Rayleigh number is $\approx 1.31 \times 10^6$.

In smaller lengths (2-4 mm), the Rayleigh number is low, suggesting that heat transfer is primarily conductive with minimal natural convection. Conversely, in larger lengths (6-10 mm), the Rayleigh number significantly increases, demonstrating that natural convection becomes dominant and improves cooling efficiency. This observation is crucial for designing AESA radar cooling systems, especially when considering electronic disturbances, e.g. Variable Gain Phase Oscillator (VGPO) and Range Gate Pull-Off (RGPO).

The characteristic parameters impacting the Rayleigh number include gravity (g), thermal expansion coefficient (β), temperature difference between the surface and ambient ($T_s - T_\infty$), characteristic length (L), Prandtl

number (Pr), and kinematic viscosity (ν). The Rayleigh number formula is confirmed by authors Park, J. et al. (2021) and Gryglewski, D. et al. (2016).

3.d.IV.a. AESA and Jamming Resistance

The calculated value for the Mean Specific Damage (DMS) for the jamming attack (as confirmed in Figure 24) is -49.38, representing the combined average impact of VGPO and RGPO disturbances on the thermal performance of the AESA radar. This negative value indicates a significant reduction in cooling efficiency, raising concerns about the robustness of the current thermal management system.

Firstly, the Damage with Jamming Resistance (DRJ) value is ranked -24.48, which, despite accounting for jamming resistance, still reflects a substantial negative impact; this suggests that existing jamming resistance measures are only partially effective and insufficient to fully mitigate the effects of VGPO and RGPO disturbances.

In second instance, the Composite Specific Damage (DCS) value of -23.72 integrates the impacts of disturbances and jamming resistance, indicating an overall high level of damage to the AESA radar's performance. To define a final trend, we consider that the persistent negative values across DMS, DRJ, and DCS highlight the significant vulnerability of the system to these disturbances.

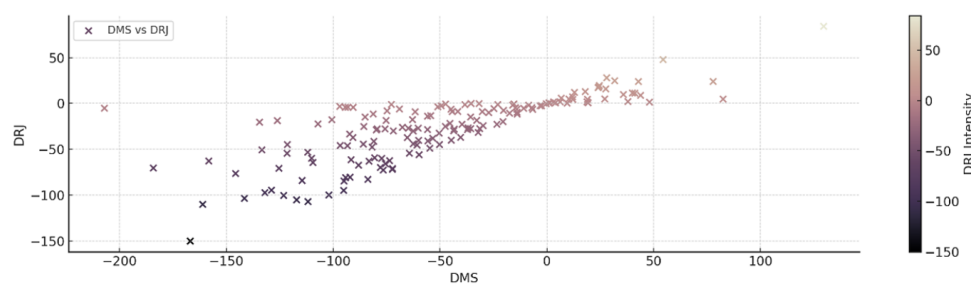


Figure 24. DMS vs DRJ.

To enhance collectively the performance of the AESA radar, it is technologically imperative to develop and implement more effective measures to reduce the impact of VGPO and RGPO disturbances; the results are crucial for applications ranging from industrial processes to advanced computing systems, where maintaining optimal thermal conditions is sensitive information.

Specifically, the correlation heatmap, generated the relationships between key factors affecting the AESA radar's performance: the correlations between VGPO and RGPO impacts are very low, indicating that these disturbances operate independently and complicate the mitigation strategy as each disturbance must be addressed separately.

Altogether, the correlation between VGPO impact and jamming resistance is also extremely low, suggesting that current jamming resistance measures do not significantly mitigate VGPO disturbances, highlighting a critical gap in the system's defence mechanisms.

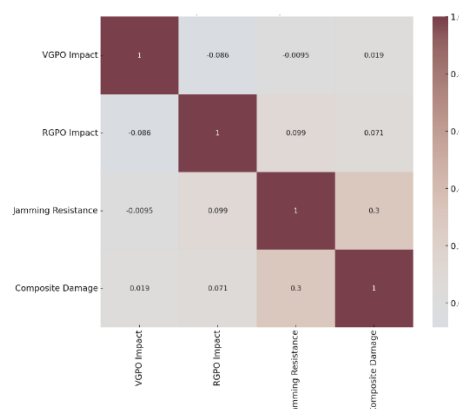


Figure 25. Correlation heatmap of EW factors impacting AESA performance.

The weak correlation between RGPO impact and jamming resistance indicates the limited effectiveness of jamming resistance measures against RGPO impacts. Although increased jamming resistance can reduce overall composite damage, the current measures are not sufficiently impactful to prevent significant performance

degradation; the Figure 25 evidence such low correlations between VGPO and RGPO impacts with composite damage suggest that while their direct contributions are minimal, their cumulative effects pose significant risks to system performance.

3.d.V. MCDA retrieved from eigenvector refinement: modulation rate (γ) and interference

After range pulse compression in the time domain was considered, a Constant False Alarm Rate (CA-CFAR) detection was lastly performed, performed in Tables 9-12, on the compressed echo signal to estimate the target X-47B range accounting A_i for the echo signal i , R_i for the range of the target i , $a_r(t)$, the range window function, f_r , frequency, B , bandwidth, gamma as modulation rate and c , speed of light, aggregated in terms of pairwise criterion, one by one, as aggregated in Table 9, normalized in Table 10, weighted in Table 11 and lastly fuzzified in Table 12:

Table 9. Example Pairwise Comparison Matrix for Criteria.

$$\begin{pmatrix} 1 & 1/3 & 1/2 & 1 & 1/3 & 1/5 & 1/7 \\ 3 & 1 & 3 & 1/2 & 1 & 1/3 & 1/5 \\ 2 & 1/3 & 1 & 3 & 1/2 & 1 & 1/3 \\ 1 & 2 & 1/3 & 1 & 3 & 1/2 & 1 \\ 3 & 1 & 2 & 1/3 & 1 & 3 & 1/2 \\ 5 & 3 & 1 & 2 & 1/3 & 1 & 3 \\ 7 & 5 & 3 & 1 & 2 & 1 & 1 \end{pmatrix}$$

Table 10. Normalized Matrix and Weights.

$$\begin{pmatrix} 0.05 & 0.03 & 0.07 \\ 0.15 & 0.09 & 0.13 \\ 0.20 & 0.14 & 0.18 \\ 0.10 & 0.13 & 0.11 \\ 0.25 & 0.31 & 0.21 \\ 0.15 & 0.19 & 0.16 \\ 0.10 & 0.11 & 0.14 \end{pmatrix}$$

Table 11. Weights (Eigenvector).

$$\begin{pmatrix} 0.10 \\ 0.11 \\ 0.14 \\ 0.13 \\ 0.21 \\ 0.16 \\ 0.15 \end{pmatrix}$$

Table 12. Results *Fuzzy AHP.

	FID	AHP	AHP*	BWM	ELECTRE	TOPSIS
	896	0.4293	0.4341	0.7187	1	3
	966	0.4892	0.4845	0.6899	2	1
	1056	0.3815	0.3814	0.7441	3	2

To match the maximization of the signal-to-noise ratio, the variables from the filter response for signal $r(t)$. Each method provides unique insights, contributing to a well-rounded assessment of the radar system's performance, numerically minimized and, hence, *defuzzified*, concluding with the fuzzy synthetic extents 0.75 from $\tilde{A}_{12} = (\frac{1}{3}, \frac{1}{2}, \frac{2}{3})$.

3.d.VI. SINR weighted in Fuzzy AHP triangular number and pairwise comparison

A consistent pattern, is validated in Tables 14-16, whereby the process of weighting SINR (Signal-to-Interference-plus-Noise Ratio) using Fuzzy AHP (Analytic Hierarchy Process) with triangular numbers and pairwise comparisons, detailed in Table 13, enhanced to solve the inherent uncertainty and vagueness of the trajectory, seen in Table 14 for Best-to-Others (BO) vs Others-to-Worst (OW), and lastly estimated, Table 15, characterizing the estimation by three parameters: the lower limit (a_1), the most likely value (a_2), and the upper limit (a_3):

Table 13. Fuzzy AHP triangular number and pairwise.

$$\begin{pmatrix} (1, 1, 1) & (2, 3, 4) & (4, 5, 6) & (6, 7, 8) \\ \left(\frac{1}{4}, \frac{1}{3}, \frac{1}{2}\right) & (1, 1, 1) & (2, 3, 4) & (4, 5, 6) \\ \left(\frac{1}{6}, \frac{1}{5}, \frac{1}{4}\right) & \left(\frac{1}{4}, \frac{1}{3}, \frac{1}{2}\right) & (1, 1, 1) & (2, 3, 4) \\ \left(\frac{1}{8}, \frac{1}{7}, \frac{1}{6}\right) & \left(\frac{1}{6}, \frac{1}{5}, \frac{1}{4}\right) & \left(\frac{1}{4}, \frac{1}{3}, \frac{1}{2}\right) & (1, 1, 1) \end{pmatrix} ;$$

Table 14. BO vs OW.

$$(1 \ 4 \ 6 \ 8) \text{ (BO)}$$

$$(8 \ 4 \ 2 \ 1) \text{ (OW)}$$

Table 15. Range estimation.

$$\begin{pmatrix} 85.92 & 16.68 & 20 & 0.5 \\ 75.34 & 12.45 & 25 & 0.6 \\ 88.45 & 20.56 & 15 & 0.4 \end{pmatrix}$$

As detailed, we accounted as AHP weights $w_1 = 0.5$; $w_2 = 0.2$; $w_3 = 0.1$, weighted S_i signal is equivalent to: $S_i(t)_{weighted} = 0.5 \cdot S_i(85.92) + 0.2 \cdot S_i(16.68) + 0.2 \cdot S_i(20) + 0.1 \cdot S_i(0.5)$ computed in **Equation 45**.

To better qualify the extent of Table 16, regular checks and periodic verification of secondary and tertiary criteria occurring at certain critical points, the formulated pairwise comparison matrix, has been raised via triangular numbers $(a_{ij}^L, a_{ij}^M, a_{ij}^U)$, completing the status of each row and column criterion.

Table 16. Fuzzy Synthetic extent.

Criteria	R	θ_{el}	θ_{azi}	A	N
R	(1, 1, 1)	(2/3, 1, 3/2)	(2, 3, 4)	(1/3, 1/2, 2/3)	(3, 4, 5)
θ_{el}	(2/3, 1, 3/2)	(1, 1, 1)	(1/2, 2/3, 1)	(3, 4, 5)	(2, 3, 4)
θ_{azi}	(1/4, 1/3, 1/2)	(1, 3/2, 2)	(1, 1, 1)	(2, 3, 4)	(1/3, 1/2, 2/3)
A	(3/2, 2, 5/2)	(1/5, 1/4, 1/3)	(1/3, 1/2, 2/3)	(1, 1, 1)	(2, 3, 4)
N	(1/5, 1/4, 1/3)	(1/4, 1/3, 1/2)	(3, 4, 5)	(1/2, 2/3, 1)	(1, 1, 1)

To support the overall analysis's accuracy beforehand manually computed, the defuzzification is equivalent for $\tilde{A}_{12}$ to 1.056 while $\tilde{A}_{13} \approx 3$.

Long-interval monitoring of backup and reserve criteria, like hopping and damage, ensures the data is ready for integration when needed; for high-priority weights, such as the No Savitsky-Golay section four unfiltered and the Savitsky filter applied, minimal but consistent monitoring is vital to ensure their availability and accuracy; to conclude, by computing iterated series of trajectories, a robust degree of consistency is consented, with regard of verification of all criteria layers noised via unbiased CRLB R estimators given by $\text{VAR}(\hat{R}) \geq \frac{1}{I(\theta)}$ whose Fisher Information Matrix (FIM) is determined by $r(t)$.

3.d.VII. Cramer-Rao Lower Bound and exponential refinement in radar spatial analysis

Describing the pattern documented in Figure 26 and brought by 3D spatial representation of radar data, we provide a comprehensive visualization of how radar signals varied for the three critical points; by incorporating CRLB (Cramer-Rao Lower Bound) and Exponential Smoothing accounting CRLB error bounds in variance estimator $\text{Var}(\hat{\theta}) \geq [I(\theta)]^{-1}$ retrieving information from the Fisher Matrix.

The Y-axis indicates the elevation angle, θ_{el} , of the vertical X-47B position, while along the X-, the range measurements (R) is represented and for the Z-, the azimuth angle, θ_{azi} , is allocated, allowing to determining the horizontal direction of the detected trajectory α smoothed at time t , x_t at factor between 0 and 1 whose smoothing α factor weighted the most recent observations given by FIM. The magnitude of CRLB values is now contextualized across a two-dimensional grid as visualized in Figure 27 and summarized in Table 17. From the extracted data, we observe that the highest values, represented by the lightest colors, are concentrated around the coordinates (229, 479), (229, 480), (229, 481), (229, 457), and (402, 482). These points signify regions of maximum intensity on the heatmap, highlighting significant clusters of high values.

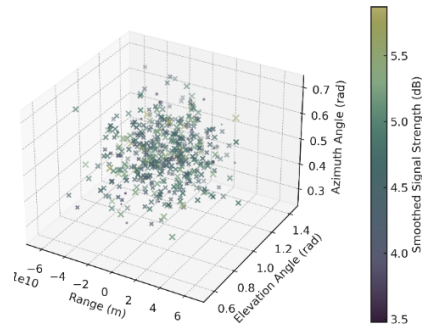


Figure 26. Cramer-Rao Lower Bound spatial intersection.

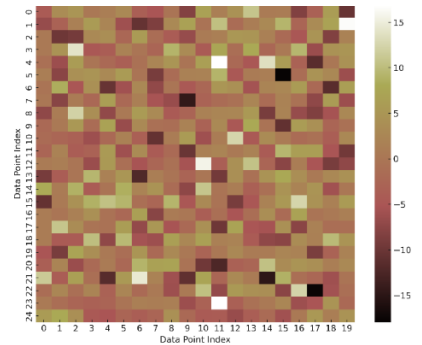


Figure 27. Heatmap of data point index from Cramer-Rao Lower.

Table 17. Heatmaps statistics.

Statistic	Mean	Median	Standard Deviation	Min	Max	25th Percentile	75th Percentile
Value	-0.000014	-0.001206	0.005612	-0.013413	0.018384	-0.002937	0.002318

The histograms presented illustrate the distribution and impact of Exponential Smoothing on various radar data parameters. Exponential Smoothing is a technique used to reduce noise and highlight significant trends in the data. By comparing the original histograms with those after smoothing, we observe that Exponential Smoothing makes the distributions more concentrated and less affected by random noise. This results in a clearer and more accurate representation of the radar data, which is crucial for improving the reliability and accuracy of radar-based measurements and estimations as portrayed in Figure 28: (a) in which the top histogram displays the distribution of range estimates with Cramer-Rao Lower Bound applied; (b) whereby the top histogram shows the distribution of elevation angles in the radar data, indicating a reduction in random variability; (c) for determining the horizontal direction of detected objects; (d) characterized by the top histogram which presents the distribution of signal strengths in the radar data.

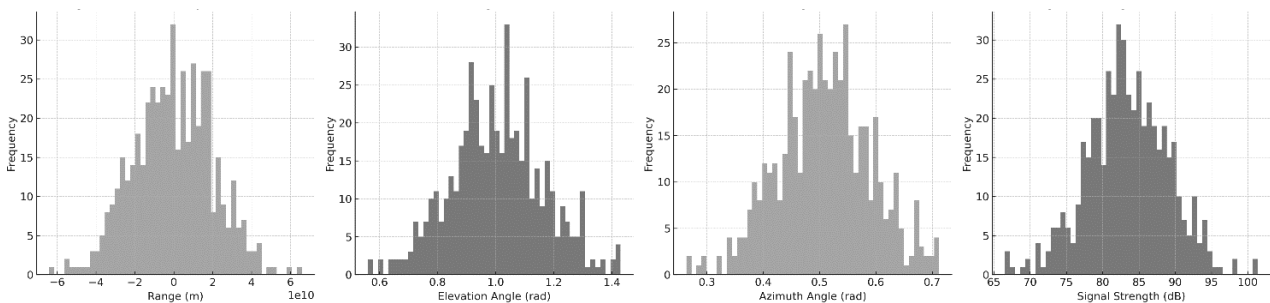


Figure 28. (a) Impact; (b) Elevation Angle Distribution; (c) Azimuth Angle Distribution; (d) Signal Distribution.

4. Discussion from the Methodology Review : identifying and mitigating biases in MCDA

This examination employs a novel aggregate approach, never before applied to the UCAS X-47B, to evaluate the effectiveness of EW countermeasures in the context of the Selinunte Heritage Park with the application of multiple MCDA methodologies currently implemented in the engineering industry.

In turn, the integration of advanced radar technologies, such as 3D AESA, frequency hopping, and sophisticated jamming resistance, underscores the necessity of advanced technological GIS/EW solutions to protect sensitive cultural heritage sites from modern electronic threats.

Specifically, a key and novel finding is the demonstrated utility of the TOPSIS method in ranking radar system performance across multiple criteria, which highlights its effectiveness in complex decision-making scenarios. The results, which position FID 966 and FID 1056 as the top performers, emphasize the importance of advanced signal processing and interference mitigation in EW operations. This prioritization aligns with the need for resilient systems capable of maintaining operational superiority in dynamic and contested environments.

To support the initial eCASS hypothesis, the framework also critically identifies vulnerabilities within the AESA radar system, particularly to jamming techniques such as VGPO and RGPO disturbances. The significant impact of these disturbances on thermal performance and the calculated Rayleigh number highlights the pressing need for enhanced thermal management systems; the review's findings suggest that current cooling mechanisms are inadequate, pointing to an area requiring urgent attention to prevent performance degradation under electronic attack.

Making comparisons with the iterative methodology, weighted sums and velocity updates have provided a dynamic framework for real-time adjustments, reflecting the adaptive nature of effective EW strategies. This approach allows for continuous optimization in response to evolving threats, which is crucial for maintaining an edge in EW deterrence.

Despite the strengths of the Methodology Review, there are still areas eligible for improvement, e.g. the weighting and normalization processes within the MCDA methodologies will benefit in future from further refinement to better account for the unpredictability of EW engagements.

5. Discussion and Conclusion: holistic communities and preserving heritage scenarios

This Methodology Review demonstrates the application of a comprehensive Multi-Criteria Decision Analysis (MCDA) approach to enhance Electronic Warfare (EW) countermeasures, specifically evaluating the UCAS X-47B's performance in the context of cultural heritage protection at the Selinunte Heritage Park. By employing methodologies such as AHP, ANP, Fuzzy AHP, BWM, ELECTRE, and TOPSIS, the research provides a multifaceted evaluation of key performance factors affecting EW systems, highlighting the crucial role of advanced radar technologies like 3D AESA and frequency hopping in safeguarding sensitive sites from modern electronic threats.

The findings reveal that the integration of sophisticated signal processing and interference mitigation techniques is essential for maintaining operational superiority in dynamic environments. Notably, the TOPSIS method proved effective in ranking radar systems, with FID 966 and FID 1056 identified as top performers, emphasizing the importance of resilient systems in contested scenarios.

Nonetheless, the study also uncovers vulnerabilities within the AESA radar system, particularly concerning susceptibility to jamming techniques such as VGPO and RGPO disturbances. These findings underscore the urgent need for enhanced thermal management systems to prevent performance degradation under electronic attack, suggesting that current cooling mechanisms might be insufficient.

Future research should delve deeper into the dynamic interactions between EW technologies and heritage protection frameworks, exploring how these advanced systems can be integrated without compromising the preservation of cultural assets. This interdisciplinary approach has the potential to foster holistic solutions that balance technological advancement with cultural conservation.

Overall, this study contributes valuable insights into the field of EW and heritage conservation, providing a foundational framework for future developments and innovations in both military and cultural preservation contexts. By addressing both the technological and cultural dimensions of EW, this review establishes a path for further exploration and application of advanced EW strategies in protected landscapes.

By demonstrating that the periodic reset mechanism might be a powerful enhancement to the standard Particle Swarm Optimization (PSO) algorithm, we, by periodically resetting particles, assume that the swarm of critical points could maintain its ability to explore new areas of the search space, thereby increasing the likelihood of finding the global optimum. Despite the additional computational cost and the need for careful parameter tuning, the benefits of periodic resets in terms of improved UCAS optimization performance make it a valuable strategy in swarm intelligence and optimization. Enhanced exploration by periodically resetting particles helps the PSO maintain a higher level of exploration, preventing premature convergence and increasing the chances of finding the global optimum. Maintaining diversity within the swarm ensures that different regions of the search space are explored, leading to better optimization results as the swarm is less likely to get trapped in local optima.

Lastly, introducing periodic resets can increase the computational load due to the generation of new random positions and velocities. The effectiveness of the reset mechanism depends on parameters such as the reset interval (TTT) and the fraction of particles to reset, which need careful tuning for different optimization problems. If the reset interval is too short or the fraction of reset particles is too high, it may disrupt the convergence process and lead to inefficiency.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. It was initiated through a joint agreement between the Department of Architecture at the Hamdullah Emin Paşa Campus of Alanya University and the Department for Training and Internationalization of the *Ordine degli Architetti, Pianificatori, Paesaggisti e Conservatori* of Naples and its Province, Italy, recognized under Royal Decree No. 2537 of October 23, 1925.

All images included in this work were created by the primary author. Acknowledgements are extended to all peers who contributed to the development of an accessible research methodology, with special thanks to the two anonymous reviewers for their insightful evaluation of the proposed framework.

Conflict of Interests

The authors declare no conflict of interest. The numerical results and their processing do not imply any responsibility in terms of the design, collection, or interpretation of data, but are exclusively intended to demonstrate appropriate and well-calibrated methodologies in support of *Valutazione di Impatto Ambientale* (VIA, Environmental Impact Assessment) and *Valutazione Ambientale Strategica* (VAS, Strategic Environmental Assessment). The research endorses the reintroduction of historically coherent and ecologically compatible components of infrastructures, promoting a sustainable approach to land use, and adopts data extraction methods that exclude animal experimentation and avoid environmentally invasive procedures, in full compliance with the rigorous Italian legislation on landscape protection.

Ethics statements

This study was conducted in accordance with the principles outlined in the European Code of Ethics for Scientific Research and adheres to the Declaration of Helsinki (2013). It received approval from the appropriate Institutional Review Board.

The research posed no harm or risk to participants, and all data collected were used solely to investigate the built environment in relation to Heritage Architecture. All data are strictly unclassified and have been made publicly available without any violation of copyright or intellectual property rights.

For any inquiries or concerns regarding the study, please refer to the official contact details of the hosting university.

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Chapter 11

Signal Denoising under Environmental Stressors in Heritage Monitoring

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Introduction

In modern communication systems, Software Defined Radios (SDRs) are crucial due to their flexibility and adaptability (Aboltins & Tihomorskis, 2023), despite of their vulnerability to low-frequency noise, which can degrade performance, especially in environments with high electromagnetic interference, sustained by Katz and Flynn (2009) who stress the importance of demonstrating communication concepts through SDR, as evidenced by White, Joseph F. (2003), by the use of a structured approach-model which emulates the simulation of circuit behaviour in microwave engineering, as also prompted by Rojhani et al. (2022) and Hu, C. et al. (2016), who offer respectively a detailed examination of location with velocity estimation, and how Kalman-based (Kalman, E., 1960, Chui, C. et al., 1991) channel tracking improves the bit-error-rate (BER) performance using Multiple Input Multiple Output (MIMO) radars in cluttered environments; in this regard, this paper introduces an enhanced SDR architecture, initiated on the premise of block diagrams (Kravchenko, V. et al., 2017), comparing conventional transceivers and a subsampling approach.

To support the hypothesis of mitigating noise, we additionally propose an integrated Kalman filter enhanced adaptively into real-time (Chen, G. et al., 1991) SDR systems, with regard of time-varying autoregressive (AR) coefficients of the signal, which are then used to compute the PSD (Zhang, G. et al., 2006), thoroughly explored by Ermolova (2009), displacing these features in Extended Fisher Information Matrices (FIMs) for real-time adjustments to noise covariance, as discussed by He, J. et al. (2024) Saho K. et al. (2015), Bashirov, E. et al. (2020), a random variable collection typical in stochastic random variables systems (Volosyuk, K. et al., 2018, Chirikjian, Gregory S. 2012); this recent demand, with reference to fine-tuned adaptation, has been critical for maintaining the Kalman filter's robustness (Xiong, et al. (2021), and ensuring accurate state estimation under challenging conditions, as supported by Batra et al. (2004), who analyze the resilience of ultra-wideband (UWB) systems in context-responsive environments (Di Mauro, L. et al., 2024).

Significantly, the proposed block diagram in Figure 1, significant of various schemes such as Relay-and-Antenna Selection (LRAS) by Hu and Kao (2016), improves SDR performance in signal detection and subsampling classification across two environments: the Extended Fisher Information (EFIM), located on the receiver side immediately after the RX (Receive Antenna), values the digital demodulated processing, decoding and advanced algorithms, amplified by Low-Noise Amplifier (LNA), coming from the Digital Signal Processing (DSP) and in first place, the Analog-to-Digital Converter (ADC) (Unbehauen, R. et al., 1989).

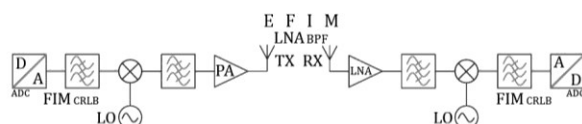


Figure 1. Block Diagram of SDR system incorporating FIM, CRLB, and EFIM.

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How to Cite This Chapter:

Polverino, S., Ahmad Nia, H., & Rahbarianyazd, R. (2025). Signal denoising under environmental stressors in heritage monitoring. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 124–135). Cinius Yayınları. <https://doi.org/10.38027/N11ICCAUA20250143>

This role is to perform the estimation of parameters alongside the FIM, as an integrated part; related to FIM, we configured the Cramér-Rao Lower Bound (CRLB), that performs resourcefully as yielded by Jones, A. et al. (1996) into the theoretical limit on the variance of unbiased $\hat{\theta}$ estimators of EFIM expected value of θ , in $E[\hat{\theta}]$ applied to spin-spin relaxation times, T_1 and T_2 .

Methods

To assess the sensitivity of SDR components to low-frequency noise, the Extended Fisher Information Matrices (EFIMs) were employed. The Kalman filter was adapted to dynamically adjust the process and measurement noise covariance matrices in real-time, guided by the EFIMs, forwarding to the cohesive state estimation process, also supported by Xiong, K. et al. (2018). Simulations were conducted across various “deliberate”, (Bashirov A., 2003), noise scenarios factoring the analytical Python modules commonly used within the scope of modelling data, such as NumPy, in the process of large arrays and matrices, Matplotlib, as a powerful data visualization tool, Simply, with regard of process-based discrete-event simulation, and TensorFlow, in terms of large-scale simulation data and the extraction of patterns.

Signals were modeled as a linear combination of known waveforms and noise, impacting the localization of front-end positionings, as for wireless sensor networks (WSNs) (Zhang, et al., 2013), in terms of scalability (Gupta, P. et al., 2000), and actualized in parallel to So (2018) whose algorithms are discerned between time-of-arrival (TOA) or time-difference-of-arrival (TDOA). By utilizing the EFIM within a dual Kalman filtering framework, we modelled how different noise environments affect the estimation process in SDRs, translated into electromagnetic interferences by Tse and Viswanath (2005). Specifically, two scenarios were considered: scenario a (Segesta site) and scenario B (Selinunte park). In the optical image of scenario A, multiple interfaces and varying material properties lead to significant signal loss and dispersion, resulting in a lower EFIM and reduced accuracy in estimating signal parameters. In scenario B, the fewer interfaces and lower loss result in a higher EFIM, thereby improving the accuracy of signal estimation and detection capabilities. The mathematical Equation 1 of the observed signal $y(t)$ is expressed as:

$$y(t) = \sum_{i=1}^N \Gamma_i \cdot T_i \cdot h_i(\theta) + n(t) \quad \text{Equation 1. Multi-Path Signal Model.}$$

where $h(\theta)$ is the signal parameterized by θ (which could represent frequency, amplitude, phase) and $n(t)$ is the noise, which varies depending on the scenario. For scenario A and B: $n_{A,B}(t) \sim N(0, \sigma_{A,B}^2)$. Γ_i is the reflection coefficient at the i -th interface, T_i is the transmission coefficient at the i -th interface and $h_i(\theta)$ represents the signal component corresponding to the path through.

1.a. Fisher Information Matrix Extension

The dual Unscented Kalman Filter (UKF) (Wan, A. et al., 2000, Van Der Merwe, R. et al., 2001, Bonnabel, S., 2007).) used can be adapted to account for these Fresnel coefficients, which are critical in predicting signal behavior, by the use of Unscented Transformation (UT), after reflections or transmissions, more conveniently than the Extended Kalman Filter (Julier, S. et al., 1997). The Fisher Information Matrix (FIM) quantifies the information that observable data carries about a parameter, θ . This formulation considers the contributions from different media, each path affecting the overall signal received. For scenarios with varying noise levels, such as urban (high noise) and rural (low noise) environments, the FIM can be adapted. In high noise, FIM values decrease, indicating reduced parameter estimation accuracy. Conversely, in low noise environments, the FIM is higher, improving signal detection.

To address these variations, the FIM is integrated into SDR performance metrics, such as probability of error (PER) and bit error rate (BER). The incorporation of chaotic systems and the use of an extended FIM within a dual Kalman filtering framework allows for dynamic adjustment of noise covariance matrices, improving SDR robustness against low-frequency noise and multipath interference. The key Equation 2, summarises the aforementioned statements:

$$\mathbf{I}(\theta) = \frac{1}{\sigma^2} \sum_{i=1}^N \left[\left(\frac{\partial(\Gamma_i \cdot T_i \cdot h_i(\theta))}{\partial \theta} \right) \left(\frac{\partial(\Gamma_i \cdot T_i \cdot h_i(\theta))}{\partial \theta} \right)^T \right] \quad \text{Equation 2. Noise-Adapted Signal Path Estimation Formula.}$$

1.a.I. Optimizing SDR Signal Detection Through FIM-Based Adaptive Algorithms

The FIM-based adaptive algorithms is discussed by Blech et al. (2010) not only quantifying the information content for parameter estimation but also redesigning software-defined ultra-wideband (UWB) transceiver in overcoming the limitations of traditional narrowband systems (Pavlikov, V. et al., 2018) in noisy environments, a common strategy for passive radar systems (Kutuzov, M. et al., 1987) and Magnetic Resonance Imaging (MRI) (Bouhrara, M.

et al., 2018); this aligns with Convex optimization techniques (Boyd, S., & Vandenberghe, L., 2004) and Sadiku and Akujuobi's (2004) observations on the need for a concise overview to instruct azimuth parameters, e.g. location movement or surface characteristics (Pavlikov, V. et al., 2018), and calibrate the adaptive capabilities of SDRs (Ramos-Perez, I. et al., 2012) in Electronic Warfare (EW) contexts, that align to AirComp systems through data fusion (Nazer, B., et al., 2007) and optimal Tx-Rx policy design under power constraints, as issued by Liu et al. (2020).

Serving as a basis for deriving performance bounds, we accounted the Cramér-Rao Lower Bound (CRLB), that provides a lower bound on the variance of unbiased ground estimators, by adopting a parameter adjustment approach inspired by Saho and Masugi (2015); their method utilizes a steady-state performance index that correlates with the root-mean-square prediction error, allowing for more precise tuning of the process noise covariance matrix in the filter.

In support of this empirical dynamic target tracking theorization, Bromiley, P. (2003) discussed in detail the convolution of Gaussian probability density functions to model the impact of noise on signal detection in non-linear (Jinan, R. et al., 2016) systems: in this regard, the FIM for scenarios, A and B, is estimated as the inversely proportional to the noise variance, σ^2 , as expressed by Equation 3:

$$\mathbf{I}(\theta) = \frac{1}{\sigma^2} \sum_{i=1}^N \left[\left(\frac{\partial S_{21}(\omega, \theta)}{\partial \theta} \right) \left(\frac{\partial S_{21}(\omega, \theta)}{\partial \theta} \right)^T \right] \quad \text{Equation 3. Fisher Information Model in Modified Transfer.}$$

The extension of our filtering approach to include differential equations, similar to the PDE-based (Partial Differential Equations) methods used by Bashirov et al. (2008), underscores the importance of advanced mathematical modeling in addressing the intricacies of modern dynamic systems.

Given that $\sigma_A^2 > \sigma_B^2$, we can expect in Scenario A, with higher noise results in a lower FIM, leading to a higher Probability of Error (PER) and Bit Error Rate (BER), while scenario B benefits from a higher FIM, indicating better signal detection accuracy.

Moreover, the integration of chaotic systems into SDRs, modeled by the chaotic spread spectrum technique coupled with the Kalman filter, further enhances signal processing robustness against low-frequency noise and multipath interference. The refined model can be extended to Ultra-Wideband (UWB) scenarios, incorporating transfer functions for the transmitter and receiver antennas, also confirmed, respectively, in Equation 4:

$$H_{N,new,TX}(\omega) = \frac{j\omega}{c_0} \sqrt{\frac{\omega}{\pi}} H_{N,new,TX}(\omega); \quad \text{Equation 4. Transfer Function of the Transmitter Antenna.}$$

Whilst the transfer function of the communication channel is represented in Equation 5, for how the signal is altered as it travels through the channel, taking into account $T_i(\omega)$, the transmission coefficient, $\Gamma_i(\omega)$, the frequency-dependent reflection coefficient at the i -th interface and τ_i represents the delay associated with the i -th path.

$$H_{CH}(\omega) = \sum_{i=1}^N \Gamma_i(\omega) \cdot T_i(\omega) \cdot e^{-j\omega\tau_i}; \quad \text{Equation 5. Transfer Function.}$$

The overall transmission parameter, $S_{21}(\omega)$ stressed mathematically in Equation 6, characterizes the communication link, with the effects of Fresnel coefficients and environmental variations:

$$h(\theta) \rightarrow S_{21}(\omega) = H_{N,new,TX}(\omega) \cdot H_{CH}(\omega) \cdot H_{N,new,RX}(\omega); \quad \text{Equation 6. Communication link } S_{21}.$$

1.a.II. Extended model in UWB systems

The FIM for this comprehensive model is given by a refinement of overall frequency-dependent effects as reported in Equation 7: reflections, transmissions, and path delays, allow for precise parameter estimation even in complex environments. In parallel, the CRLB, derived from the FIM, provides insights into the achievable precision of parameter estimation, guiding the design of more resilient SDR systems.

$$(\theta) = \frac{1}{\sigma^2} \sum_{i=1}^N \left(\frac{\partial \left(\frac{j\omega}{c_0} \sqrt{\frac{\omega}{\pi}} H_{N,new,TX}(\omega) \cdot \sum_{i=1}^N \Gamma_i(\omega) \cdot T_i(\omega) \cdot e^{-j\omega\tau_i} \cdot \frac{1}{c_0} \sqrt{\frac{\omega}{\pi}} H_{N,new,RX}(\omega) \right)}{\partial \theta} \right)$$

Equation 7. Derivative version of the Fisher Information Model parameterization in UWB.

1.a.III. Adaptive Noise Mitigation in SDRs with Extended Fisher Information Matrix

By deriving the Cramér-Rao Lower Bound (CRLB) from the FIM, determining the minimum variance achievable for unbiased estimators, $\text{Var}(\hat{\theta}) \geq \text{CRLB} = \frac{1}{I(\theta)}$. The observed signal y is modeled as $y = h(\theta) + n$. The Fisher Information Matrix (FIM) is given by Equation 8:

$$I(\theta) = \frac{1}{\sigma^2} \left(\frac{\partial h(\theta)}{\partial \theta} \right)^2 \quad \text{Equation 8. FIM-Based Analysis of Signal Parameter Sensitivity.}$$

Using basic parameters $h(\theta) = \theta^2$ and $\sigma^2 = 1$, the FIM is $4\theta^2$, and the CRLB is $1/4\theta^2$. By refining the model and increasing the Signal-to-Noise Ratio (SNR), the CRLB is reduced further, showing improved estimation precision. With data fusion techniques doubling the FIM, the CRLB can be minimized, leading to even greater accuracy in signal estimation.

1.a.IV. FIM and Kalman Filtering for Enhanced State Estimation in SDRs

The Fisher Information Matrix (FIM) is tightly linked to the Cramér-Rao Lower Bound (CRLB), offering a lower bound on the variance of unbiased estimators, as for indicating how the estimation of one parameter influences the estimation of another, i.e. $I_{\theta_m \theta_m} = 1/\text{CRLB}(\theta_m)$ along the off-diagonal.

By incorporating parameters, θ_m , ϵ_{rm} , ϕ , d_{pvm} , d_{GHm} , the FIM captures the covariance between these parameters, reflecting their interactions under a Rayleigh clutter model or similar scenarios joint estimation. The Kalman filter, integrated with the FIM, improves state estimation by dynamically adjusting the process and measurement noise covariance matrices. This is essential in low-frequency noise environments, where the Kalman filter updates state predictions and corrections to maintain accuracy.

The association of such prediction-correction model, where it predicts the state based on a previous state and corrects it using current measurements, is integrated in terms of covariance between the parameters and their dynamic state estimations by adding Kalman gain, K_{θ_m} , for the parameter θ_m , reflecting how the Kalman filter adjusts the state estimate based on new observations; its updated form is presented in Equation 9 while the measurement update follows in Equation 10:

$$P_{k|k-1} = F_k P_{k-1|k-1} F_k^T + Q_k(I_{LF}) \quad \text{Equation 9. Covariance Matrix Update for State Prediction.}$$

$$K_k = P_{k|k-1} H^T (H P_{k|k-1} H^T + R)^{-1} \quad \text{Equation 10. State Correction Gain in Kalman Filtering.}$$

By incorporating in FIM, stated in Equation 11, we observe $P_{k|k-1}$, that represents the predicted error covariance matrix, K_k , the Kalman gain, and H_k , the observation matrix.

$$FIM_{\text{Kalman}} = \begin{pmatrix} \frac{1}{\text{CRLB}(\theta_m)} + K_{\theta_m} & \text{Cov}(\theta_m, \epsilon_{rm}) + K_{\theta_m, \epsilon_{rm}} & \text{Cov}(\theta_m, \phi) + K_{\theta_m, \phi} & \text{Cov}(\theta_m, d_{pvm}) + K_{\theta_m, d_{pvm}} & \text{Cov}(\theta_m, d_{GHm}) + K_{\theta_m, d_{GHm}} \\ \text{Cov}(\epsilon_{rm}, \theta_m) + K_{\epsilon_{rm}, \theta_m} & \frac{1}{\text{CRLB}(\epsilon_{rm})} + K_{\epsilon_{rm}} & \text{Cov}(\epsilon_{rm}, \phi) + K_{\epsilon_{rm}, \phi} & \text{Cov}(\epsilon_{rm}, d_{pvm}) + K_{\epsilon_{rm}, d_{pvm}} & \text{Cov}(\epsilon_{rm}, d_{GHm}) + K_{\epsilon_{rm}, d_{GHm}} \\ \text{Cov}(\phi, \theta_m) + K_{\phi, \theta_m} & \text{Cov}(\phi, \epsilon_{rm}) + K_{\phi, \epsilon_{rm}} & \frac{1}{\text{CRLB}(\phi)} + K_{\phi} & \text{Cov}(\phi, d_{pvm}) + K_{\phi, d_{pvm}} & \text{Cov}(\phi, d_{GHm}) + K_{\phi, d_{GHm}} \\ \text{Cov}(d_{pvm}, \theta_m) + K_{d_{pvm}, \theta_m} & \text{Cov}(d_{pvm}, \epsilon_{rm}) + K_{d_{pvm}, \epsilon_{rm}} & \text{Cov}(d_{pvm}, \phi) + K_{d_{pvm}, \phi} & \frac{1}{\text{CRLB}(d_{pvm})} + K_{d_{pvm}} & \text{Cov}(d_{pvm}, d_{GHm}) + K_{d_{pvm}, d_{GHm}} \\ \text{Cov}(d_{GHm}, \theta_m) + K_{d_{GHm}, \theta_m} & \text{Cov}(d_{GHm}, \epsilon_{rm}) + K_{d_{GHm}, \epsilon_{rm}} & \text{Cov}(d_{GHm}, \phi) + K_{d_{GHm}, \phi} & \text{Cov}(d_{GHm}, d_{pvm}) + K_{d_{GHm}, d_{pvm}} & \frac{1}{\text{CRLB}(d_{GHm})} + K_{d_{GHm}} \end{pmatrix}$$

Equation 11. Fisher Information Model comprehensive of Kalman and CRLB.

1.b.I. FIM-Based Signal Estimation in UWB Systems with Complex Path Interactions

These modifications enable the Kalman filter to maintain high accuracy in state estimation despite the presence of low-frequency noise, proposing a novel FIM expression, otherwise detailed inside the partial derivative $\frac{\partial}{\partial \theta}$ in the context of Ultra-Wideband (UWB) with respect to the parameter θ , by summing multiple reflections, transmissions, or paths indexed by I , in a multipath environment, by incorporating in Equation 12: i) $\frac{1}{\sigma^2}$, our normalized Inverse Noise Variance, which scales the FIM by the noise variance σ^2 ; ii) angular frequency ω , the speed of light c_0 , and a frequency-dependent scaling factor $\frac{j\omega}{c_0}$ – both of them are related to a unique term which introduces a phase component to the UWB signal propagation; iii) $H_{N, \text{new}, TX}(\omega)$, or Transmitter Transfer Function, normalizing as a transfer function of the transmitting antenna, in the same manner, representing how the signal is affected by the transmitting hardware; iv) $\sum_{i=1}^N \Gamma_i(\omega) \cdot T_i(\omega) \cdot$

$e^{-j\omega\tau_i}$, or Summed Reflections and Transmissions, composed by $\Gamma_i(\omega)$ – the reflection coefficient at the i -th interface, representing the portion of the signal that is reflected – $T_i(\omega)$, the transmission coefficient, and $e^{-j\omega\tau_i}$, the phase shift due to the time delay τ_i , accounting the signal's travel time and phase change over the distance; v) $\frac{1}{c_0} \sqrt{\frac{\omega}{\pi}} H_{N,new,RX}(\omega)$, a term inclined to the front-end connotation, representing how the signal is affected by the receiving hardware.

$$\mathbf{I}(\theta) = \frac{1}{\sigma^2} \sum_{i=1}^N \left(\frac{\partial}{\partial \theta} \left[\left(\frac{j\omega}{c_0} \sqrt{\frac{\omega}{\pi}} H_{N,new,TX}(\omega) \cdot \sum_{i=1}^N \Gamma_i(\omega) \cdot T_i(\omega) \cdot e^{-j\omega\tau_i} \cdot \frac{1}{c_0} \sqrt{\frac{\omega}{\pi}} H_{N,new,RX}(\omega) \right) \right] \right)^2$$

Equation 12. Frequency-Dependent FIM in UWB Systems with Path-Based Distortions.

1.b.II. Covariances for FIM indicates parameters and CRLB (Cramer-Rao Lower Bound)

The measurement variances integrated the theoretical model (Pogorelyuk, L. et al., 2021) through a Kalman filter approach: i) the process started from relevant features from the Figures 2 and 3, establishing for orientation θ_m , computed as 90 degrees, bounding box area, 68,055 square pixels to infer size-related parameters like distance and edge detection which is estimated in terms of variance, e.g. $Cov(\theta_m, \phi)$;

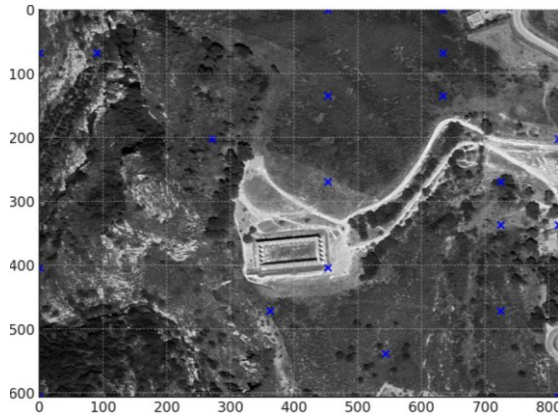


Figure 2. FIM₁ orientation.

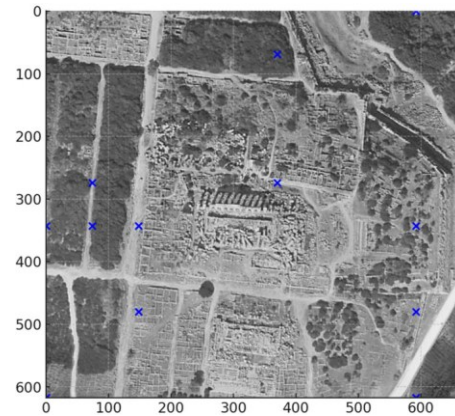


Figure 3. FIM₂ orientation.

ii) in the second instance, the FIM matrix incorporated the variability in the detected edges, orientation across multiple observations, as from the Kalman filter and CRLB for bounding box's precision; iii) critical of this theoretical approach, was the time-series requirement data, for which a simplified approach considered: a) the variance in orientation, θ_m , in parallel to precision in the Bounding image processing; b) covariances based on potential correlations between orientation and edge detection; c) Kalman filter' application refined in a Bayesian robust estimation (Durovic, M. et al., 1999); iv) the incorporation of CRLB parameters deliver the two corresponding FIMs, given in Equation 13 and 14, with parameters listed in Table 1.

$$\mathbf{FIM}_{\text{Segesta}} = \begin{pmatrix} 3.00 & 1.10 & 1.05 & 1.02 & 1.03 \\ 1.10 & 4.33 & 1.08 & 1.04 & 1.03 \\ 1.05 & 1.08 & 3.50 & 1.04 & 1.07 \\ 1.02 & 1.04 & 1.04 & 6.00 & 1.03 \\ 1.03 & 1.03 & 1.07 & 1.03 & 2.67 \end{pmatrix}$$

Equation 13. FIM₁ Covariance values.

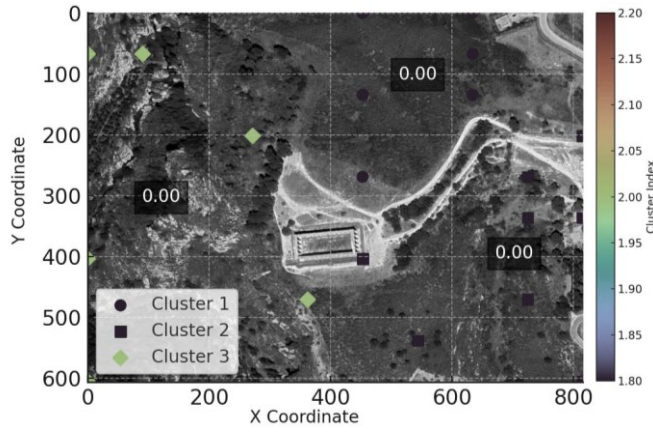
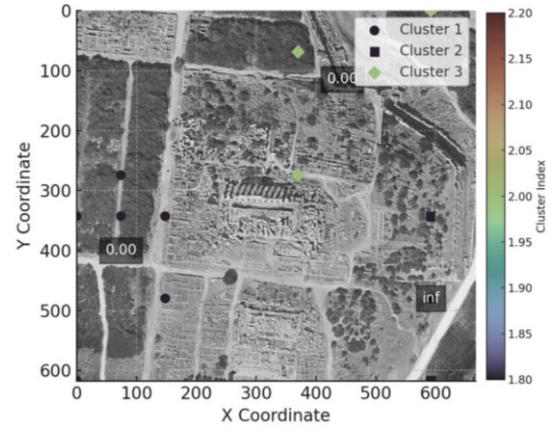
$$\mathbf{FIM}_{\text{Selinunte}} = \begin{pmatrix} 2.43 & 1.15 & 1.10 & 1.03 & 1.05 \\ 1.15 & 3.50 & 1.12 & 1.06 & 1.05 \\ 1.10 & 1.12 & 3.00 & 1.06 & 1.10 \\ 1.03 & 1.06 & 1.06 & 4.33 & 1.05 \\ 1.05 & 1.05 & 1.10 & 1.05 & 2.25 \end{pmatrix}$$

Equation 14. FIM₂ Covariance values.

Table 1. CRLBs parameters.

	θ_m	ϵ_{rm}	ϕ	d_{pvm}	d_{GHm}
FIM ₁	0.5	0.3	0.4	0.2	0.6
FIM ₂	0.7	0.4	0.5	0.3	0.8

Visually, Figures 4 and 5 respectively report the densities registering a higher density of Selinunte, with one of the clusters characterized by a very tightly packed points, which could be due to specific image features or noise.

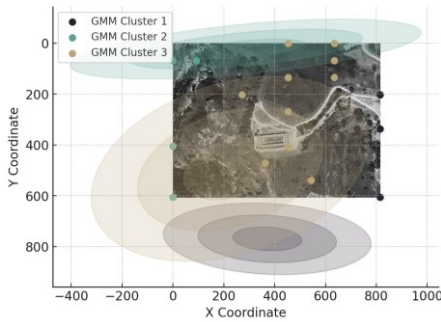
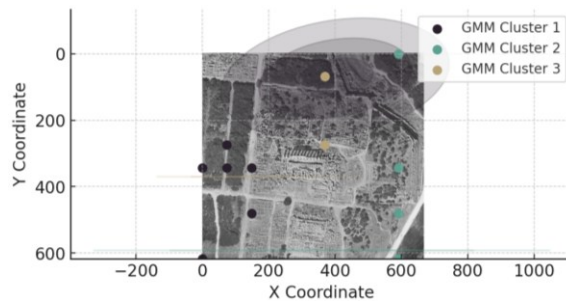
Figure 4. FIM₁ Covariance mapping.Figure 5. FIM₂ Covariance mapping.

In parallel to this, the aggregated covariance matrices for each cluster are quantified as follows in Table 2 with a mismatch for Cluster 2, 0.0000905 and infinity, respectively due to image limitations.

Table 2. Densities.

$\begin{bmatrix} 0.5 & 0.231 \\ 133.2 & 0.12 \end{bmatrix}$	1 FIM 1)	0.000164	$\begin{bmatrix} 0.5 & 0.228 \\ 134.7 & 0.12 \end{bmatrix}$	1 FIM 2)	0.00169
$\begin{bmatrix} 0.5 & 0.240 \\ 135.6 & 0.12 \end{bmatrix}$	2 FIM 1)	0.0000905	$\begin{bmatrix} 0.5 & 0.240 \\ 129.7 & 0.12 \end{bmatrix}$	2 FIM 2)	infinity
$\begin{bmatrix} 0.5 & 0.253 \\ 133.2 & 0.12 \end{bmatrix}$	3 FIM 1)	0.0000447	$\begin{bmatrix} 0.5 & 0.231 \\ 136.9 & 0.12 \end{bmatrix}$	3 FIM 2)	0.000131

Regarding the Gaussian Mixture Model (GMM) Silhouette, we registered for the first scenario, portrayed in Figure 6, a score equivalent to 0.32, while 0.38 for the second, represented by Figure 7, yielding positive silhouette scores in both images, indicating that the clusters, (K), identified by GMM are reasonably well-separated and well-defined and capturing the structure of the data in both scenarios by sampling two critical parameters (Smiti, A. et al., 2012): ϵ (Eps), the neighbourhood radius, and $MinPts$, the minimum number of points required to form a cluster.

Figure 6. FIM₁: GMM DBSCAN.Figure 7. FIM₂: GMM DBSCAN.

This visual enhancement of Density-Based Spatial Clustering of Applications with Noise (DBSCAN), particularly effective in handling noise and identifying clusters of arbitrary shapes as for optical and SAR images, (Hu, H. et al., 2017), was incentivized by the adoption of a Bayesian Kalman Filter which incorporated prior distributions into the estimation process, providing a more informed and potentially more accurate estimate, especially when prior knowledge is relevant, which is represented in Equations 15 and 16, with regard of posterior mean estimate of the state $\hat{x}_{k|k}$ at time k , given the observations z_k , and the second, the posterior covariance matrix $P_{k|k}$, which quantifies the uncertainty associated with the state estimate $\hat{x}_{k|k}$:

$$\hat{x}_{k|k} = \int \theta P(\theta | z_k) d\theta \quad \text{Equation 15. Posterior Mean Estimate in Bayesian Filtering.}$$

$$P_{k|k} = \int (\theta - \hat{x}_{k|k})(\theta - \hat{x}_{k|k})^T P(\theta | z_k) d\theta \quad \text{Equation 16. Covariance Matrix Update in Bayesian Estimation.}$$

1.c. Frequency-Specific Noise Impact on RF Signal Processing

This flexibility of software-defined ultra-wideband (UWB) is a core advantage of software-defined radios (SDRs) in UWB systems within the frequency range spanning from 0 to 3 GHz, which covers the spectrum of interest for high-frequency communication systems, including the third Nyquist zone, here designated in correspondence of the Kalman and theta features given in both scenarios.

The use of a high-pass filter with a cut-off frequency of 2.15 GHz, mentioned in Figure 8, is designed to suppress unwanted spectral components below 2 GHz with considerable heavy-tailed distribution (Hongpo F. et al., 2022).

The Power Spectral Density (PSD) evaluation based on Kalman ground estimators (Aboy, M. et al., 2004) given in Figure 8, is now defined as indicated in the graph of Figure 1, in the filtering of the digital demodulated processing, decoding and advanced algorithms, where valleys below 2 GHz appear in both AOI 1 and AOI 2, reflecting the effectiveness of the filtering process, whose quantization process of mapping to discrete levels, leading to a loss of information is also theorized by Romero, D. et al. (2017).

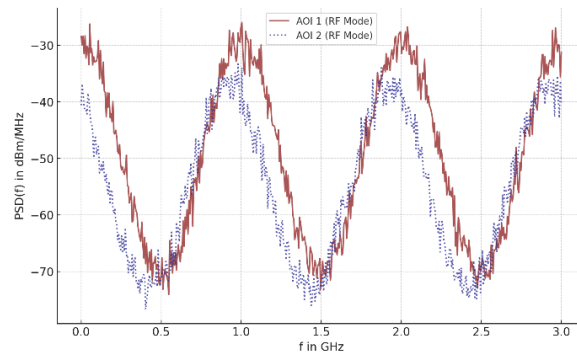


Figure 8. Power Spectral Density of RF Mode in AOI 1 and 2.

The significant attenuation observed below 2 GHz indicates that the filter is performing as expected, reducing the power of signals in that frequency range, which aligns with the behaviour of a high-pass filter. Overall, the statements provided are consistent with the graphical evidence, effectively explaining the function and performance of the UWB transceiver and the associated high-pass filtering process, into how DGS can be used to achieve desired filter characteristics such as sharp roll-off and compact size for performance improvement (Wanchun, T. et al., 2012) (Federal Communication, Commission, 2002).

2. Signal Variability in UWB Networks

Amplified by Low-Noise Amplifier (LNA), retrieved from the Digital Signal Processing (DSP) and the Analog-to-Digital Converter (ADC), the comparison of the UWB network efficiency between first and second Area-of-Interest finds place, revealing distinct differences in both the spatial distribution of signal power and temporal signal stability. In the Segesta dataset, the mean normalized signal power, μ_1 , is calculated to be 0.327, indicating a lower average signal strength across the measured area. This lower signal strength is coupled with a standard deviation, σ_1 , of 0.170, reflecting a relatively high variability in the signal power.

This variability, expressed in Figure 9 and 10, suggests significant fluctuations in the UWB network performance within the Segesta environment, likely due to non-uniformities in the spatial coverage and potential interference from environmental factors.

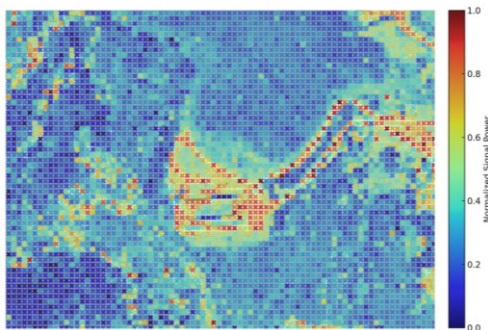


Figure 9. UWB₁' Repeaters.

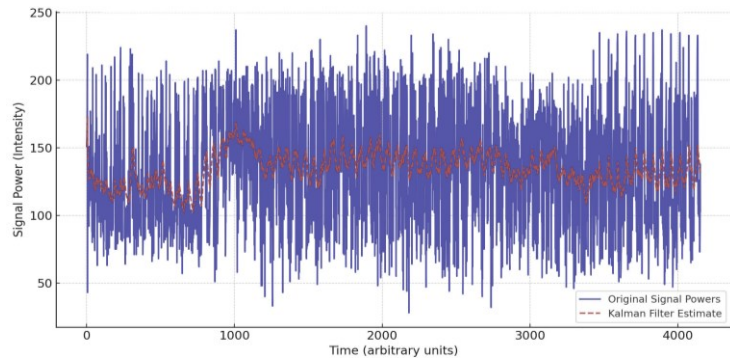


Figure 10. UWB Efficiency.

In contrast, the Selinunte dataset, represented in Figure 11, exhibits a higher mean normalized signal power, highlighted in Figure 12, μ_2 , of 0.452, indicating a more robust and consistently stronger UWB network performance. The standard deviation in this scenario, σ_2 , is slightly lower at 0.169, compared to Segesta, signifying a marginally more stable signal with less fluctuation in power levels.

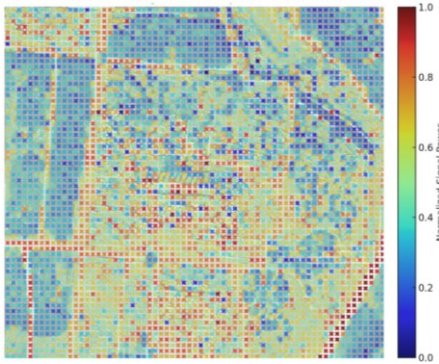


Figure 11. UWB2' Repeaters.

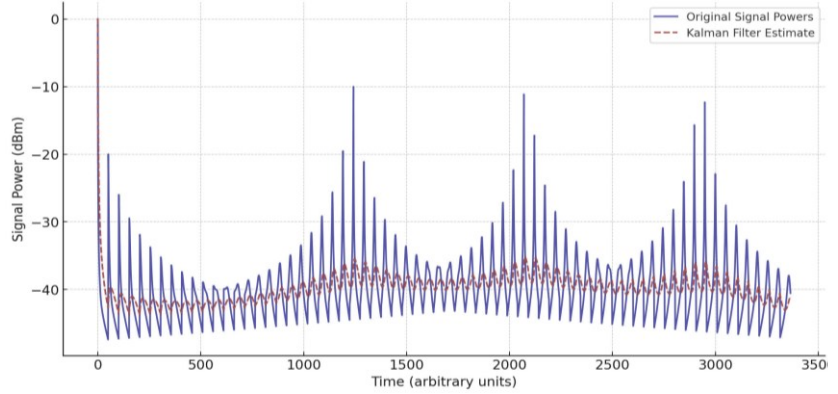


Figure 12. UWB Efficiency.

The difference in mean signal power, $\Delta\mu = 0.125$, underscores the superior signal quality of the first context, suggesting that the UWB network in this area benefits from better spatial coverage and fewer disruptions. The blended 3D visualization, obtained in Figure 13, enables a direct comparison of signal power distributions across the two scenarios within the same spatial domain: for instance, regions where the Z-axis values are higher indicating stronger signal power, suggesting more effective UWB coverage.

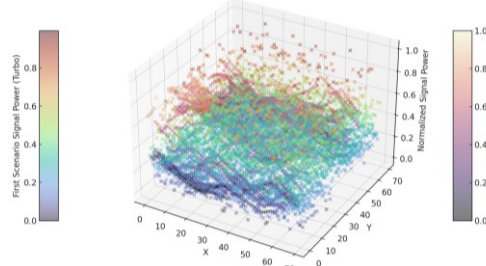


Figure 13. UWB Network Efficiency across the two scenarios.

The overlap of color schemes in certain spatial regions highlights areas of convergence or divergence in signal strength between Segesta and Selinunte.

Frequency-Specific Noise Impact on RF Signal Processing

The Kalman filter needs to account for these discrete components when predicting and correcting the signal, so that starting from the Power Spectral Density (PSD), we initially calculated the comparisons, employing a simpler approach based on the Fourier Transform (FFT), given in Equation 17,

$$X(f) = \sum_{n=0}^{N-1} x(n) \cdot e^{-j 2 \pi f n / N} \quad \text{Equation 17. Fourier Transform.}$$

where $x(n)$ is the time-domain signal, N is the number of samples across the two contexts, and $X(f)$ is the Fourier Transform of the signal. The corresponding PSD was subsequently computed as the magnitude squared of the FFT in the following Equation 18, related to Figure 14,

$$PSD(f) = |X(f)|^2 \quad \text{Equation 18. Fourier Transform.}$$

and converted to decibels (dBs) in Equation 19 and 20, related respectively to Figure 15:

$$PSD_{dB}(f) = 10 \cdot \log_{10}(PSD(f)) \quad \text{Equation 19. Fourier Transform.}$$

$$PSD(f) = \frac{\sigma_b^2}{T_{sym}} |G_{s,RF}(f)|^2 \frac{1}{Z_c} + \frac{\mu_b^2}{T_{sym}^2} \sum_{m=-\infty}^{\infty} |G_{s,RF}(f)|^2 \frac{1}{Z_c} \delta\left(f - \frac{m}{T_{sym}}\right) \quad \text{Equation 20. Power Spectral of RF.}$$

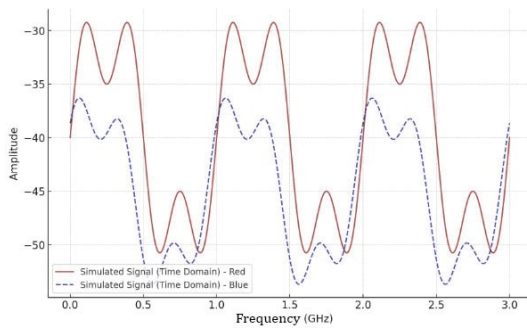


Figure 14. FFT Magnitude of PSD.

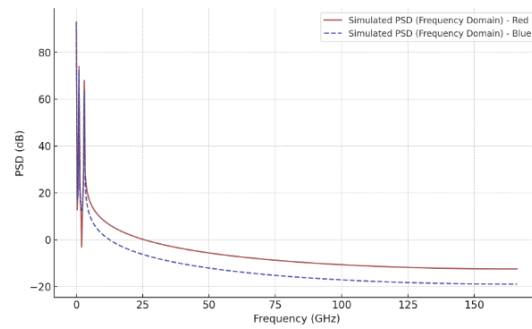


Figure 15. PSD converted to dB.

Conclusion

The integration of extended Fresnel Interface Models (FIMs) into SDR systems effectively mitigates low-frequency noise, enhancing system resilience in challenging environments, particularly urban areas with prevalent multipath effects. The adaptive Kalman filter, augmented with Fresnel coefficients, improves signal detection sensitivity, even for weaker signals affected by multiple reflections. By the same token, comparative analysis shows that the Gaussian Mixture Model (GMM) outperforms DBSCAN in cluster identification, as indicated by positive silhouette scores and clear visual clustering. Accordingly, the proposed approach strengthens SDR systems, escalating against diverse noise conditions, offering a robust solution for RF signal processing.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. It was initiated through a joint agreement between the Department of Architecture at the Hamdullah Emin Paşa Campus of Alanya University and the Department for Training and Internationalization of the *Ordine degli Architetti, Pianificatori, Paesaggisti e Conservatori* of Naples and its Province, Italy, recognized under Royal Decree No. 2537 of October 23, 1925.

All images included in this work were created by the primary author. Acknowledgements are extended to all peers who contributed to the development of an accessible research methodology, with special thanks to the two anonymous reviewers for their insightful evaluation of the proposed framework.

Conflict of Interests

The authors declare no conflict of interest. The numerical results and their processing do not imply any responsibility in terms of the design, collection, or interpretation of data, but are exclusively intended to demonstrate appropriate and well-calibrated methodologies in support of *Valutazione di Impatto Ambientale* (VIA, Environmental Impact Assessment) and *Valutazione Ambientale Strategica* (VAS, Strategic Environmental Assessment). The research endorses the reintroduction of historically coherent and ecologically compatible components of infrastructures, promoting a sustainable approach to land use, and adopts data extraction methods that exclude animal experimentation and avoid environmentally invasive procedures, in full compliance with the rigorous Italian legislation on landscape protection.

Ethics statements

This study was conducted in accordance with the principles outlined in the European Code of Ethics for Scientific Research and adheres to the Declaration of Helsinki (2013). It received approval from the appropriate Institutional Review Board.

The research posed no harm or risk to participants, and all data collected were used solely to investigate the built environment in relation to Heritage Architecture. All data are strictly unclassified and have been made publicly available without any violation of copyright or intellectual property rights.

For any inquiries or concerns regarding the study, please refer to the official contact details of the hosting university.

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Chapter 12

Folk Music Heritage Conservation: Adaptive Reuse of Hason Residence

Jonaid Tasnim Pranto, Kawshik Saha

Introduction

Hason Raja, a pioneer of Bengali folk music, mysticism, and philosophy, is a key figure in Bangladesh's cultural heritage. This research aims to preserve his legacy through the conservation of architecture, specifically his ancestral home. As a zamindar, Hason dedicated his life to shaping a distinctive music heritage, deeply intertwined with Sufi traditions. For over a century, his ancestral residence has been serving as a school of thought for folk music heritage, bearing his memories and authentic shreds of evidence. The goal of this study is to conserve Raja's legacy of Bengali folk music through architectural conservation, proposing an adaptive reuse approach, reimagining the space as a commemorative site honoring his literature, philosophical, and musical contributions. This fosters a timeless memory landscape merging cultural heritage with sustainable development, fostering a dynamic space where contemporary practitioners can engage with his legacy while preserving the essence of his philosophy integrated through architecture. Heritage policy and scholarship in Bangladesh, South Asia, emphasize physical monuments overlooking living traditions. The Antiquity Act of 1968 in Bangladesh protects historic buildings but includes no provisions for safeguarding intangible cultural heritage such as folk and mystical music practices. (Abeer, 2025). Similarly, UNESCO's 2003 Convention on Intangible Cultural Heritage includes music, dance, and oral traditions as intangible cultural heritage worthy of protection. (Chatzigrigoriou et al., 2021). Such traditions may be celebrated in theory but lack concrete preservation mechanisms in architectural practice, as these have not yet been completely incorporated into local conservation frameworks. Moreover, research on adaptive reuse and heritage architecture typically focuses on material conservation (building form, authenticity, function) with keen attention to intangible cultural values specific to cultural backgrounds. The living traditions solely tied to a place are seldom considered in the design of a reuse project. This research highlights the critical gap in intangible cultural conservation approaches in Bangladesh and makes the link between built-environment strategy and the conservation of living musical traditions that remain underexplored.

Dewan Hason Raja (1854-1922) was a zamindar of Bengal who later turned mystic poet and songwriter from the Sylhet region of Bangladesh. Hason led his initial days off worldly privilege. He later underwent a very profound spiritual awakening. In this phase, he composed hundreds of folk songs that explore themes of love, enunciation, and the unity of existence. Hason's work—deeply rooted in Bengali folk tradition—influenced South Asian culture, and his songs are cherished in devoted folk literature. This research is an attempt to preserve Hason Raja's folk music heritage combined with multiple conservation approaches, including intangible cultural heritage conservation, adaptive reuse, and architectural design.

This research aimed to address whether architectural intervention in Hason Raja's paternal residence serves as a living repository for his mystic poetic and musical legacy. With this acknowledged context of cultural heritage, the research question included the question: Can the adaptive reuse of Hason Raja's residence conserve and revitalize the intangible folk-music traditions associated with him? This research examines if reimagining this homestead as a "living memoryscape" adds value to the context for sustaining and sharing this spiritual and musical tradition of Hason Raja. This paper addresses the gaps discussed by proposing an ideal design framework that explicitly integrates intangible folk heritage into an adaptive reuse project. In contrast to conventional restorations that treat any historic building simply as an artifact, this approach treats Hason residence as a dynamic vessel for cultural memory. The study develops a concept of memory landscape design, in which physical spaces are aligned

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How to Cite This Chapter:

Pranto, J. T., & Saha, K. (2025). Folk music heritage conservation: Adaptive reuse of Hason Residence. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 136–148). Cinius Yayınları.
<https://doi.org/10.38027/N12ICCAUA2025EN0392>

with the themes and narratives of Hason Raja's songs. For example, propose performance courtyards and exhibition spaces that reflect his mystical lyrics, as well as landscape interventions that evoke images from his poetry. The study offers a methodology for embedding intangible heritage into the site. It shows how architecture can be used not just to preserve a building but to embody and communicate the community's musical traditions and philosophy.

Intangible Cultural Heritage Conservation

The UNESCO 2003 Convention defines “practices, representations, expressions, knowledge, skills—as well as the instruments, objects, artifacts, and cultural spaces associated therewith—that communities recognize as part of their cultural heritage” as intangible heritage. It is the transmission across generations and notes domains such as “oral traditions and expressions, including language,” “performing arts,” and “social practices, rituals, and festive events.” (Text of the Convention for the Safeguarding of the Intangible Cultural Heritage - UNESCO Intangible Cultural Heritage, 2003, Article 2). Cultural heritage is not just limited to monuments: “It also includes traditions or living expressions inherited from our ancestors...such as oral traditions, performing arts, social practices [and] rituals.” (What Is Intangible Cultural Heritage? - UNESCO Intangible Cultural Heritage, 2004).

In this project, Hason Raja's musical legacy clearly falls within intangible heritage. His folk songs are oral/performing arts and devotional practice. UNESCO has recognized related traditions in Bengal. Bangladeshi Baul songs were inscribed on the Representative List of Intangible Heritage (2008) as embodying a syncretic mystic tradition. UNESCO describes Bauls as “mystic minstrels” whose “music and way of life have influenced a large segment of Bengali culture.” (Baul Songs - UNESCO Intangible Cultural Heritage, 2008). Such descriptions underscore how Hason Raja's corpus of folk music and oral poetry—likewise rooted in mystic and syncretic philosophy—constitutes a living intangible heritage. Safeguarding his heritage thus requires attention not only to his house but also to the music, lyrics, and spiritual practices that animate it.



Figure 1. LOCAL MUSICAL GATHERING AT THE BANK OF SURMA RIVER ACROSS HASON RAJA'S HOUSE, 2024

Vernacular Architecture Heritage in Sylhet region

Sylhet city's traditional urban fabric includes the unique Bangla Baton house type—a late 19th-century urban vernacular style evolved from Assam-style dwellings. Research on these houses notes that Bangla Baton houses are an “urban vernacular archetype” of Sylhet, historically introduced when this region was part of colonial Assam. These houses (also called “Ikra houses” for their reed walls) replaced older mud-bamboo huts by offering a more fire-resistant, comfortable home. They use light timber post-and-beam frames with hand-planed wood planks and bamboo lattices, onto which local ikra reed and plaster were applied. Iron bolts and sheet-metal joints were adopted after the 1897 earthquake to provide flexibility. (Saha et al., 2021).

Materially and spatially, Bangla Baton houses are climate-adapted. Sylhet's subtropical monsoon climate (high humidity and heavy rains) led builders to emphasize ventilation and shelter. Rooms are very tall (typically 4-5m ceiling height) and sit on raised platforms. The houses include overhanging eaves and a continuous front veranda that provide deep shade. Floor plans are often organized around an open, semi-outdoor courtyard: a veranda running the length of the façade leads through an “inner court” buffer into the private zones. (Saha et al., 2021).

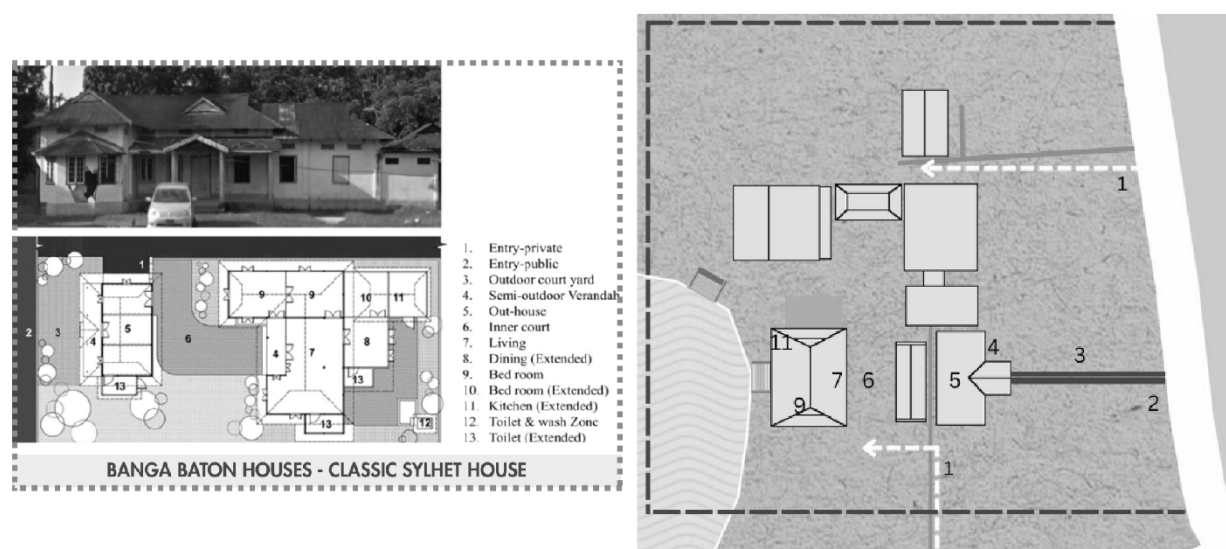


Figure 2. COMPARING LOCAL BANGLA BATON HOUSES TO COMPOSITION OF HASAN RESIDENCE

Hason Raja's own residence shares some vernacular traits but also contrasts sharply with the Baton style. His family home is now a museum, a century-old "tin shade" building with a large front piazza. The house has a pitched roof in corrugated metal sheets and its walls are solid masonry or timber rather than bamboo weave. It features a formal gate opening onto a front courtyard. (Wikipedia contributors, 2024). The composition of the Hason Residence aligns with the generic pattern of Bangla Baton houses, such as separate public/private entries, outhouse-in-house features buffered with courtyards, etcetera.

Spirituality, Mysticism and preserving memory in Architecture Design

Architectural expressions of mystic ideas and memory are seen in sites like Lalon Shah's shrine and in institutions like Santiniketan. Fakir Lalon Shah (a 19th-century musician) left a deep spiritual legacy in Bengal. After his death, his burial place at Cheuriya (Kushtia) was deliberately transformed into an akhara (spiritual gathering ground). A concrete mausoleum was erected over his tomb, and later an academy building with an auditorium and museum was added to the complex. This architecture is modest—a simple shrine rather than a grand mausoleum—reflecting Lalon's teaching that "the body itself is my temple." It functions powerfully as a living memorial: each year thousands of disciples convene here in song and prayer. UNESCO observes that this tradition is conveyed through oral transmission and thus recognizes it as an intangible cultural heritage.

In contrast, Rabindranath Tagore's Santiniketan (West Bengal) illustrates a philosophically driven campus. UNESCO's World Heritage description highlights Santiniketan as an "outstanding crystallization of Tagore's universalist vision." The campus architecture deliberately departs from colonial conventions, drawing instead on ancient, medieval, and folk Indian traditions to embody Tagore's ideals. Buildings are simple, often open-sided structures set beneath tree canopies, open-air classrooms under banyan trees that reflect Tagore's emphasis on unity with nature and fusion of learning and art. In sum, both the Lalon shrine and Santiniketan demonstrate how built form can embody and preserve memory: they make tangible the mystical or pedagogical ideas of a culture, using architectural layout and style as mnemonic vessels.

The Antiquities Act, 1968 - Bangladesh

The Antiquities Act, 1968, was established to "consolidate and amend the law relating to the preservation and protection of antiquities." (Antiquities_Act_1968_English, 1968). The Act defines "ancient" as anything dating to more than a century prior to enactment and an "antiquity" as "any ancient product of human activity, movable or immovable, illustrative of art, architecture, craft, custom, literature, morals, politics, religion, warfare, science, or any aspect of civilization or culture." (Antiquities_Act_1968_English, 1968). Crucially, however, the act's scope is grounded in tangible objects or places—it does not address intangible expressions (such as songs, oral poetry, or rituals) in its definitions or provisions.

A historic building (such as Hason Raja's residence) could be declared an immovable antiquity of archaeological and historical interest, activating these protective measures. Indeed, ancient monuments previously declared under the older 1904 act were automatically deemed protected antiquities under the 1968 act. However, the Act's tangible focus reveals a critical limitation: it says nothing about living traditions or intangible heritage.

Adaptive Reuse for historic architecture conservation

Heritage scholarships view adaptive reuse as a sustainable conservation strategy that adds new life to old buildings. The aim is to extend a structure's useful life by finding compatible new functions while safeguarding its character. Authors note reuse "extends the building's life" and is often "the most environmentally sound approach" to conserving heritage structures. Reusing avoids demolition waste and thus aligns with ecological sustainability. Technical guidelines in preservation echo these themes through principles of minimal intervention and reversibility. Researchers argue that adaptations should follow the rule "as much as is needed, as little as required, ensuring that new work does not obliterate historic fabric. Any additions or alterations "should be capable of being removed" in the future. In practice this means retaining original materials and forms wherever possible and choosing new uses that fit the existing structure.

Adaptive reuse often involves layering new meanings onto a site. Converting a historic house into a museum or cultural centre is an "interpretive" reuse that both conserves the building and activates it as an educational narrative. (Armstrong et al., 2023). For instance, transforming Hason Raja's residence into a folk-music museum would add an interpretive layer-galleries or displays narrating his story—while preserving the house's architecture. Reuse planning should engage community values and local traditions, not just physical conservation. By following minimum-change, reversible design practices and thoughtfully interpreting heritage, adaptive reuse can ensure that buildings like Hason Raja's house remain both intact and socially meaningful for future generations.

Methodology of the research

This research employs a multidisciplinary, qualitative, design-led methodology combining literature and archival research, site investigation, and, in the end, conceptual design development. The study starts with reviewing Hason Raja's life, Bengali folk music, and heritage conservation literature to comprehend the cultural context. Parallel to this, an in-depth case study of the Hason residence documenting its existing architecture, landscape, and community significance. Thorough discussions have been done with great-grandchildren of Hason Raja, local experts, and community stakeholders to capture intangible memories, narratives, and values attached to the site. Spatial analysis techniques and cultural memory mapping are used to identify and assess the tangible and intangible attributes of the place. The study also incorporates a value assessment tool and comparative analysis with regional vernacular house types to ensure proposed interventions align with both conservation best practices and local traditions. Based on this contextual analysis, conservation strategies have been proposed, including floor plans, visualizations, and narrative design that translate intangible heritage values into architectural design. This iterative process is similar to other heritage conservation studies on field surveys and stakeholder input guiding these strategies. For example, research emphasizes that "data from field surveys, stakeholder interviews, and secondary research inform recommendations for conservation strategies." Integrating these methods, this study develops a coherent design strategy: adaptive reuse and landscape design layout that integrate Hason Raja's musical memory.

Identifying heritage values and attributes with site analysis

Hason Raja's residence has evolved from a 19th-century private rural estate into a focal point of cultural memory in Sunamganj, Sylhet. Over time, it has become a public heritage symbol and museum associated with Hason Raja's legacy. Today, even in a neglected state, the site attracts visitors who revere Hason's contribution to Bengali folk culture. It reflects a broader trend in enshrining an artist's home as a site of collective heritage. This historic site has suffered from decades of abandonment and damage during the great 1897 Assam earthquake, yet it remains an emblem of Hason Raja's era. It now stands as a tangible reminder of a mystic-poet landlord's life and the history of late-colonial Sylhet.

Spatial Configuration

The architecture of Hason Raja's house exemplifies vernacular Sylheti residential design, sharing features with regional "Bangla Batton" houses. There is an inner courtyard (angan) wrapped with generous verandas. A continuous veranda along the front façade as a semi-outdoor living space and transition between inside and outside. These facilitate ventilation, light, and family activities while also ensuring privacy in line with indigenous spatial norms. This arrangement parallels the Bangla Batton houses of Sylhet. The Hason residence followed this model, integrating public-facing spaces (for receiving guests or tenants) with more secluded private quarters around the courtyard, much like Sylheti urban vernacular compounds. (Saha et al., 2021).

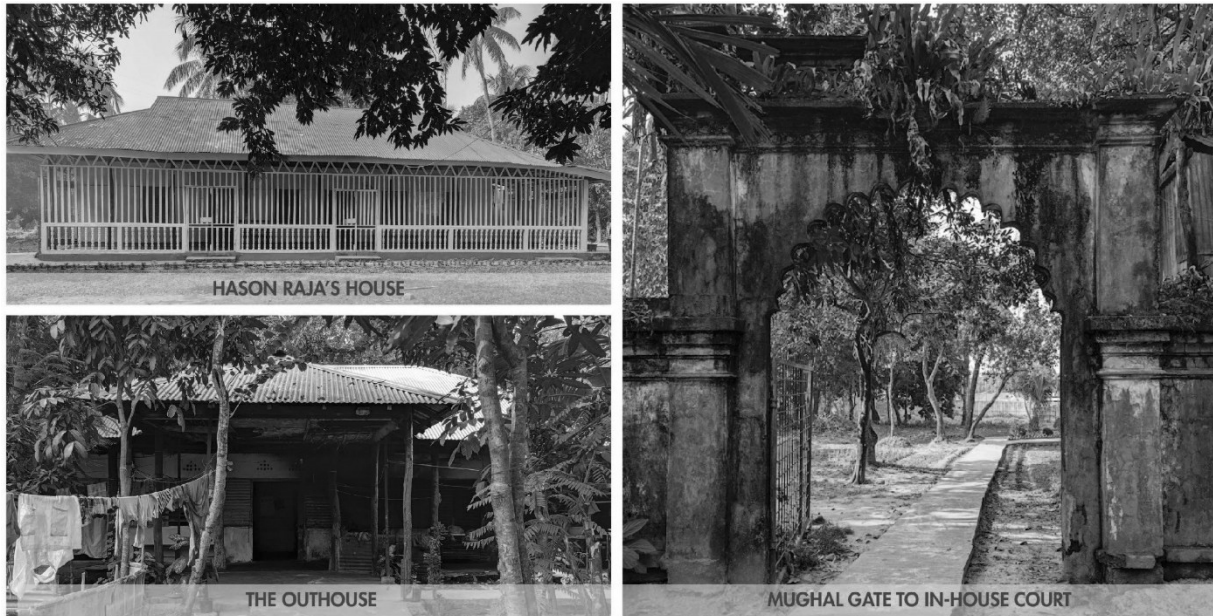


Figure 3. SITE IMAGES OF outhouse, GATE TO INHOUSE AND INHOUSE

Material and Structural Features

The residence's construction also reflects regional techniques. These buildings had shallow foundations with a masonry plinth, and in some cases, no deep foundation at all due to the lightweight ikra (reed and bamboo) construction of the walls. The walls of Hason Raja's home were likely of the ikra type—a lattice of reed or bamboo plastered with mud and lime—which was common in Sylhet's vernacular architecture. Its modular wooden panels and infill of reeds created a distinctive black-and-white grid appearance once white lime plaster was applied over the dark structural wood. The roof was almost certainly a pitched corrugated iron (CI) sheet roof with gabled ends, as was fashionable in late 19th-century Assam and Sylhet, often adorned with floral eave boards and drop ornaments in the Assamese style. Ornamented wooden posts would have supported the wide eaves of the veranda, and high jalousie windows and ventilators were used for circulation, reflecting both aesthetic detail and adaptation to heavy rains. These correspondences with regional architecture not only affirm the dwelling's authenticity but also provide a baseline for architectural analysis. (Saha et al., 2021).



Figure 4. STRUCTURAL RELEVANCE OF HASON RESIDENCE TO BANGLA BATON

Material and Structural Features

Hason Raja composed many of his mystic folk songs, drawing inspiration from the natural beauty of the haor (wetland) landscape and the spiritual traditions of Bengal. His songs directly invoke imagery of home and impermanence. He famously sang “Loke bole bolere, ghar-bari bala nay amar” (“People say I have no grand house; what dwelling can I build as an unseen shrine?”), (Issue-I, 2019). expressing a philosophical detachment from material wealth. The residence thus served as a space of poetic creation: oral histories suggest Hason Raja often wrote and performed on the wide front veranda, accompanied by indigenous instruments, for both family and local audiences. Hason Raja held court in the semi-public outer rooms, engaging with community members that gave the house a second life as a cultural salon under Hason’s patronage.

Hason Raja underwent a transformation from a life of luxury to one of spiritual introspection—he embraced Sufi ideals of love and divine unity, and in his songs, he even referred to himself as a *baula* (mad ecstatic devotee). The residence was not merely a home but a sacred locale where Hason practiced and reflected on metaphysical themes that later flowed into his lyrics. His compositions intertwine Islamic Sufi concepts with Vaishnava and Baul imagery, exemplifying Bengal’s syncretic spiritual culture. (Safi Ullah, 2023).

Condition Assessment

A survey of Hason Raja’s house raises urgent conservation concerns. The structure stands in ruin due to decades of neglect that led to crumbling walls, rotten woodwork, and a partially collapsed roof. Weathering and biological growth affected the earthen plaster and timber elements over time. The historic courtyards are overgrown, and the once-plinth has eroded, undermining structural stability. It is on the verge of ruin, with debris accumulating and unsympathetic alterations by squatters or local users over time. A large pond is alive in the back, once integral to the setting, now polluted like the overall environmental degradation of the site. Despite the physical decay, important authentic materials survive. Many original construction elements—such as portions of the *ikra* reed walls, carved wooden posts, and iron roof trusses—are extant, albeit in fragile condition. The surviving fabric offers the opportunity to preserve and showcase original 19th-century craftsmanship if stabilized properly. Any adaptive reuse effort will need to balance conservation of these authentic elements with necessary reconstruction. The philosophy of “minimal intervention” would suggest reinforcing the existing structure to the extent possible to keep the patina of age and original materiality visible. (Issue-I, 2019) (Siddiquee, 2013).

The decaying site causes onlookers to spontaneously remember lines of his music—“*matir o pinjirar majhe bondi hoiya re, kandey Hason Rajar mon moyna re*” (“caged in this earthen prison, Hason Raja’s soul” weeps)—effectively linking the physical ruin to the poet’s own words. The house’s current state carries a poignant sense of age value and historic aura that many modernized sites lose. Its weathered surfaces and original materials anchor the authentic “story” of Hason Raja’s life, providing a tangible link to the past that people can experience directly. Preserving some portion of the ruin as a ruin—consolidating it rather than completely rebuilding it—could thus serve to honor this memory value. Any adaptive reuse plan must document the current condition. It should also catalog the provenance of materials to guide decisions about repair or replacement in a manner that respects material authenticity.

Value Assessment

Tangible and intangible heritage values are assessed on Hason Raja’s residence in accordance with contemporary conservation theory. On the tangible side, the house possesses evident architectural-historical value: physical structure, layout, and materials embody a vernacular building tradition. (Saha et al., 2021). The tangible fabric also has technical value as a record of indigenous craftsmanship and age value in the weathered surfaces enduring for over a century.

Equally, the intangible values are attached to the site—the living heritage of music, myth, and meaning that it symbolizes. The intangible heritage associated with the site includes the oral traditions of Hason’s lyrics, the folklore and anecdotes about his life, and the spiritual practices that were once carried out there. UNESCO and ICOMOS frameworks increasingly emphasize that such intangible aspects must be safeguarded. In heritage management terms, the site continues to inspire community identity and spiritual reflection. The memory of Hason Raja’s mysticism is inseparable—a classic case of “sense of place” where tangible and intangible fuse. Modern conservation practice advocates identifying all such values through stakeholder engagement and research, then managing the site in a way that respects the multivalence of heritage—its multiple layers of value.

Intangible and tangible values help inform an adaptive reuse strategy. Tangible values—such as historic layout and architectural ambience suggest that any new use should adapt in a way that preserves key spatial features and showcases original materials. Intangible values—the songs, the memories, the spiritual resonance suggest that the new use should actively celebrate and continue those living traditions. Integrating new uses, such as an exhibit or performance space for folk music, will keep Hason’s music alive on-site. These will commemorate intangible heritage in line with the idea of “living heritage” conservation. (Zhang & Zhang, 2023). Adaptive reuse will transfer not just physical fabric but also cultural content to future generations, interpreting the poetic legacy and

maintaining the site as a place of inspiration and reflection. This assessment aligns with current heritage conservation paradigms; preserving a folk musician's residence is not only about maintaining an old structure but also safeguarding the songlines and stories woven into its fabric. The adaptive reuse must be conceived as a synergy of conservation and cultural continuity so that the songs, values, and creative spirit it embodies are passed onto future generations.

Spatial Value Assessment of the Historic Area

At the entrance, a gate and outer court serve as a semi-public gathering space, while an inner court is reserved for family and close guests. The outer courtyard, buffered by the Mughal wall and granary storage, historically functioned as a social hub for the community. By contrast, crossing the outer court into Hason Raja's living quarters marked a threshold into the intimate, contemplative domain of the poet, illustrating a pronounced public-to-private gradient in spatial experience. (Khan, 2022).

Hason Raja's own courtyard and pond likely witnessed informal music sessions and gatherings, reinforcing a living connection between architecture and intangible heritage. The design of the residence—with a welcoming front yard and water body— would have naturally supported folk song performances, storytelling, and contemplative solitude by the water. It reflects cultural zoning where secular and sacred activities comfortably coexisted on site. (Khan, 2022).

The spatial layout embodies intangible values and memories tied to Hason Raja's life and work. Hence, preserving the spatial configuration—the courtyard where he may have sung or recited poetry and the pond where he reflected—is vital to retaining the site's spirit of place.

Identifying Architectural Heritage Values and Defining Adaptive Reusing Policy

The songs, poetic legacy, and associated rituals of Hason Raja are as important to conserve as his house. Any adaptive reuse policy must therefore uphold cultural continuity: the storytelling, musical performances, and spiritual practices linked to the site rather than leaving the site in silence. Hason Raja's residence can be conserved as a living heritage site that celebrates both his architecture and his art.

Policy: Under Bangladesh's Antiquities Act (1968), the site qualifies as a protectable antiquity. It has historic, architectural, and cultural significance and must be conserved under government oversight. (Negligence in Conserving Heritage Sites Unacceptable, 2025). This framework establishes that any alteration to the site should respect its original character, and obliges authorities to ensure the site's protection according to global standards. Principles from UNESCO and ICOMOS provide a conservation ethos: the Venice Charter states not only the monument but also its setting are integral to its significance. The ICOMOS Charter on the Protection of Cultural Heritage and other doctrinal texts advocate for safeguarding intangible values.

Table 1. TABLE OF COMPARISON AND RELEVANCE OF SITE ELEMENTS AGAINST ASPECTS OF MEASURE

Element	Cultural	Philosophical	Literary	Lifestyle	Historical	Aesthetic	Total Score (30)
Pond	5	5	5	4	5	5	29
Granary Pavilion	1	2	1	4	4	3	15
Plinth of the House	5	5	5	5	5	4	29
Assembly Porch	2	3	2	5	5	4	21
Old-Wall	1	1	1	1	3	4	11

Adaptive Reuse Principles

Reversibility: Any modern addition has to be designed as reversible, so it can be removed or undone in the future without permanent damage to the original fabric.

Minimum Intervention: The design adheres to the maxim of retaining the authentic building materials and layout to the greatest extent and only undertaking works that are absolutely required for structural stability, safety, or new function. The historic architecture is seen as a document of the past— its original walls, form, and

finishes should remain legible and not be obscured by excessive alterations. Repairs can be done using traditional materials to maintain material integrity. (Heritage, 2021).

Authenticity: The adaptive reuse will uphold the truthful expression of the site's cultural identity. It is preserving both the physical authenticity and the intangible spirit of the place. As the Nara Charter notes, authenticity is conveyed through a heritage site's ability to express its historic meaning and context. In practice, this means we will avoid falsification of history: new elements will be contemporary and distinguishable on close inspection, and will not reconstruct lost features unless there is solid evidence, nor introduce themes that contradict Hason Raja's story. The goal is to let Hason Raja's own legacy "speak" through the site—maintaining the ambience of his era and the atmosphere of mysticism tied to his persona. By following charters like the Burra Charter (Australia ICOMOS), the adaptive reuse strategy ensures that any adaptation "does not distort the meaning of the place" and that the cultural significance, including use and associations, is respected in design decisions. (Heritage, 2021).

Referential Cases

Lalon Shah's Akhra, Kushtia (Bangladesh): The complex of another mystic songwriter, Lalon Fakir, integrates intangible heritage with site conservation. The living sacred place annually hosts thousands of devotees for music festivals and spiritual gatherings. The site is managed to support performances and accommodate pilgrims, protecting the site's use and spirit and enhancing its relevance. This approach shall make Hason Raja's residence a venue for folk music events and contemplation, not merely an artifact under glass.

Santiniketan, West Bengal, India: Rabindranath Tagore's Santiniketan is a UNESCO World Heritage cultural landscape, a model for holistic conservation of a cultural campus. The site preserves early 20th-century university buildings and ashram spaces, continuing to function as an educational and artistic community. UNESCO praised Santiniketan as "the physical manifestation of a utopian ideal... a crucible for intellectual and artistic ideas" that still conveys Tagore's philosophy. (Chakraborti & Chakraborti, 2023). This case underlines the importance of keeping Hason Raja's site active and interpretive: encourage educational and cultural programming so that the site remains intellectually and artistically alive in spirit.

Bhitargaon Temple Interpretation Zone, Kanpur, India: Bhitargaon Terracotta Temple has been coupled with the creation of an interpretation zone, with visitor access and understanding. The temple, being fragile, is protected by a buffer, and information panels and guided paths allow visitors to appreciate its history from a respectful distance. This approach enhances public engagement and tourism, ensuring the monument's safety. (Singh, 2019). This conservation strategy for Hason Raja's residence incorporates a dedicated interpretation strategy to educate visitors about Hason Raja's life and Bengal's folk music heritage without overcrowding or physically straining the tangible heritage.

The adaptive reuse policy identifies the residence and its landscape as a multi-valued heritage, architecturally as a vernacular landmark, and culturally as a cradle of mystic folk music. The policy suggests minimal, reversible interventions that safeguard these values, guided by both local laws and international best practices. This framework aims for a balanced approach: protect the past while breathing life into the present, ensuring the site's relevance for future generations.

Preparing Master Plan and Architectural Design

The design intention is to treat the entire premises as an experiential landscape of folk music heritage, where every zone has a sympathetic use and nothing is arbitrary. This subdivides the site into functional zones, both meeting new user needs and respecting the historic spatial order. The circulation is carefully planned so that visitors intuitively move from public to more private/sacred spaces, as in the original spatial composition of the estate. This journey ensures that the sanctity of Hason Raja's personal spaces is maintained.

Key design strategies and architectural approach:

Peripheral Slabs: New structures built along the periphery of the built forms, rather than crowding the historic houses. Concentrating new construction at the edges, to preserve open sightlines and the central void of the courtyard, keeping the historic sites as the focal point. This creates a buffer between the historic area and the outside context.

Pathways & Controlled Circulation: The design introduces defined pathways, that harmonize with the site, ensuring that foot traffic does not trample sensitive areas. Controlled circulation implies that certain routes are designated for general visitors, while other areas might remain restricted or accessible only during guided tours. It is informed by heritage site management practices where visitor flow is engineered to balance access and conservation. This becomes a journey through his poetry. Small seating areas or pause points along the way allow visitors to stop, listen to recorded music, or read interpretive plaques, enriching the experience.

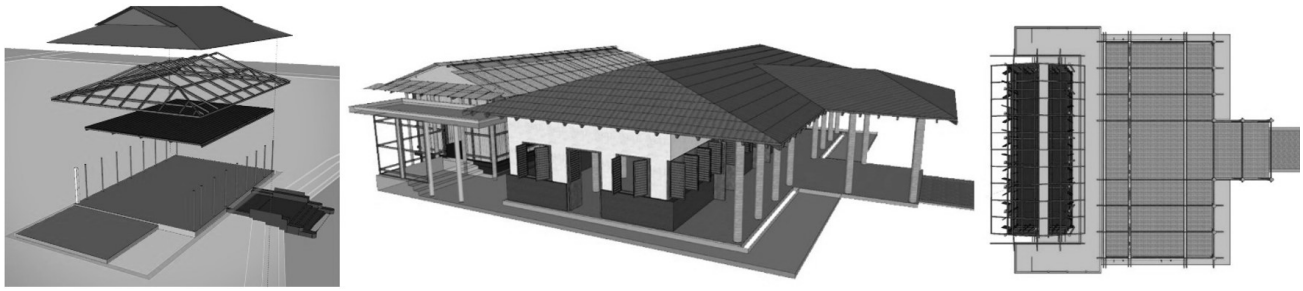


Figure 5. EXAMPLE OF PERIPHERAL SLAB FOR CIRCULATION AND VISITOR EXPERIENCE, AROUND AND THROUGH HERITAGE BUILDING

Buffer Zones and Landscape Edges: One critical buffer along the pond's edge, will be treated as a soft landscaped zone— perhaps with grass, reeds, and appropriate planting— to maintain a visual and environmental cushion in front of the house. This green fringe around the pond not only preserves the original picturesque quality but also acts as a natural barrier discouraging too close an approach to the house façade. These absorb rain runoff, provide shade, and keep the microclimate cooler for outdoor music events. Here, the pond's edge might even be developed into a small interpretation garden.

"Invisible" Foundations and Ramps: New foundations for any added structures will be of an "invisible" type that does not disturb archaeological layers of the site. This corresponds to the principle of reversibility— foundations can be removed with negligible trace. Any contemporary structures will use modern materials in a transparent or deferential design to keep focus on the heritage building leaving the 150-year-old structure as it was.

The master plan incorporates principles of cultural placemaking and sustainability returning the site to its historical role as a cultural node. The result is a master plan protecting the sanctity of Hason Raja's residence and inviting people to engage with the folk music heritage in a meaningful way.

Proposed Adaptive Reuse Design

The Hason Raja's residence is not just a physical restoration but a living museum that safeguards intangible cultural heritage—specifically the rich legacy of Bengali folk music and mystic traditions. Museums today are called on to preserve both "the tangible and intangible heritage of humanity," (International Council of Museums, 2023). using their spaces and resources to keep traditions and living expressions alive.

The design stratifies the experience into sensory layers that mirror the layers of memory and meaning associated with the site. This approach draws on museum design strategies, blending media to create emotional resonance like in the Fado Museum (Lisbon). (Castelo-Branco & Sánchez-Fuarros, 2023). Similarly, the concept uses multisensory cues—the echo of a folksong, the play of shadow and sun, or a quiet enclosure— to trigger cultural memory. Thus, architecture becomes a storytelling medium, guiding visitors through an unfolding narrative of Bengali folk heritage. This reflects a spatial narrative, where spaces are sequenced to "evoke emotions, communicate ideas, and immerse us in narrative journeys." (Siddiqui, 2023).

The program introduces several key experiential elements, addressing a facet of intangible heritage preservation.

Song Archive & Listening Pods: Listening pods allow visitors to sit and listen to curated recordings in solitude. UNESCO calls for transmission of intangible heritage to the next generation. The archive room's ambience should be like a library: filtered light, comfortable seating, and visual displays of lyrics, encouraging visitors to delve into songs' meanings. Providing a dedicated song archive and recording/listening facility, the design ensures that Hason Raja's compositions are preserved as living and accessible rather than just as static exhibits.

Courtyard Amphitheater: Courtyards can be reimagined as modest amphitheaters for live performances, community gatherings, and practices. The design preserves the house's courtyard and adds terraced seating on the existing plinth, creating a small outdoor stage without altering the original footprint. This allows the museum to host folk music performances under the open sky, in the very homestead of the poet. For instance, the National Folk Museum (Lok Virsa) in Islamabad pairs indoor exhibits with an outdoor folk amphitheater, creating a "lively" space where music and dance bring the museum to life. (Reflect and Respond: Understanding Lived History Through the Lok Virsa Heritage Museum, 2024). Courtyard Amphitheatre will let visitors experience the collective and participatory side of Bengali folk culture.

Hason Reflective Spaces: These spaces have to be intentionally sparse and dim, with minimal exhibits; perhaps a single poignant verse of Hason Raja or a subtle sound installation. The concept is akin to the serenity of Hason philosophy, where people engage in silent contemplation and realization of the deeper meaning of life. The sequential contrast from music performance to silence is a deliberate narrative device, underscoring the multiple layers of memory embodied in the site.

Interpretation Wall: The site contains a Mughal wall. The wall is partially damaged and reparable at some points and conservable at some sections. It can act as a dynamic canvas for storytelling— featuring curated photographs and bilingual lyrics of Hason Raja’s songs, historical context about Bengali folk music, and audiovisual snippets. One section could display the genealogy of Bengali folk music. Another section might be a lyric wall— where verses of famous songs are printed alongside English translations and can be heard via touch-activated speakers.



Figure 6. CURRENT CONDITION OF MUGHAL GATE AND ENTRANCE THROUGH IT TO INNER COURT

Spatial Strategy

The spatial strategy is governed by principles of minimal intervention, reversibility, and respect for the original architecture of Hason Raja’s home. Historical elements of the building are preserved or restored in situ.

Preserving the Plinth and Layout: The original plinth of the house can be retained. This plinth is the base of the courtyard and building, with both practical and heritage importance. Culturally, the plinth defines the footprint and spatial organization of the traditional site; preserving it means the “grounding memory” of the place remains intact.

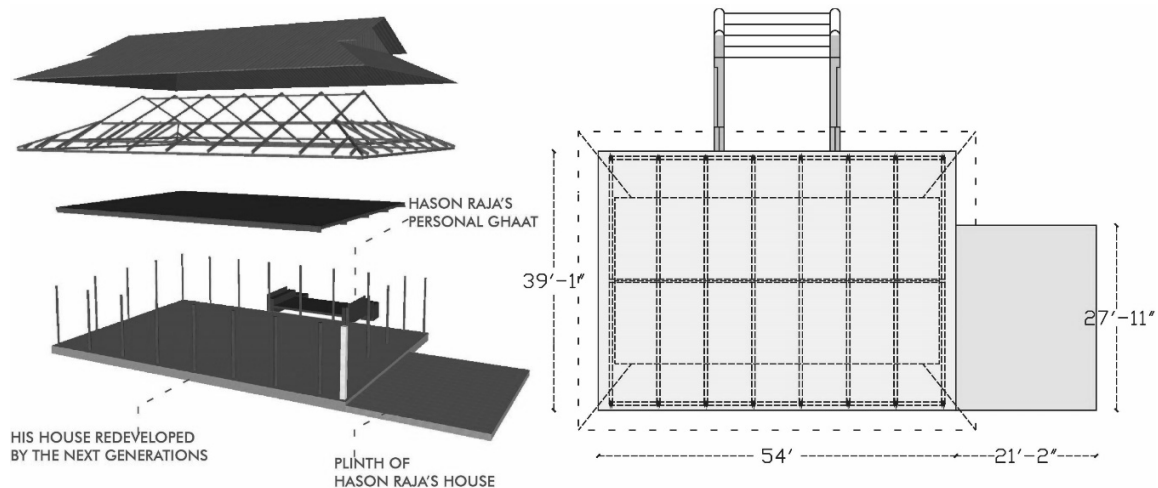


Figure 7. DOCUMENTATION OF PLINTH OF HASON RAJA'S HOUSE

Reversible Exhibition Insertion: The benefit of reversibility is twofold: it protects the authenticity of the heritage structure, and it leaves room for future reinterpretation. A classic example of this strategy is the adaptation of the Bibliothèque Nationale in Paris, where “lightweight, removable structures were installed to update facilities without altering the historic design.” These interventions are to be “integrated into the architecture...without compromising the building’s original aesthetics.” (Architectours, 2025).

Material Strategy

The material palette has to be deliberately kept sustainable and locally appropriate to honour traditional building practices and to ensure a low environmental footprint, aligning with heritage restoration norms.

Clay and Lime: The original walls of the house are made of brick and lime mortar, typical of 19th-century Bengal. Reusing these materials continues a lineage of craft. Besides this regulates humidity and temperature inside with locally sourced plaster that echoes traditional construction methods. Clay and lime-based materials tie the new interventions back to the original fabric, ensuring visual harmony.

Timber: Wood has been historically used in the house's structural system. This can be salvaged from original teak or jackfruit wood elements and restored. This allows the structure to be light and reversible. It also subtly infuses the design with the aesthetics of folk culture.

Reuse of Existing Materials: The conservation process reuses materials from the site itself, embracing the adaptive reuse ethos down to the material level. This recycling approach not only minimizes waste but also keeps the historic materials in continuous use, further layering the memory within the site.

In summary, the material strategy reinforces both authenticity and sustainability.

Experiential Layers - Movement through Space

The spatial experience will symbolically mirror Hason Raja's own journey through music and spirituality, unfolding in a sequential experiential journey. The spatial choreography has to be, therefore, calibrated as a narrative experience, from the moment one enters the premises to the point of exit. It has to be biographical and thematic, tracing the arc from Hason Raja's worldly life steeped in folk culture to his later ascetic, philosophical phase, and situate his legacy in the broader stream of Bengali musical heritage.

The journey begins at the open courtyard facing the Surma River, where visitors will get their first impressions. It is for live performances and open spaces dedicated to local musicians. This space is the prologue, establishing the connection between the tangible heritage and the intangible context of Hason Raja.

Upon entering the site, visitors shall encounter the most extroverted layer: the vibrancy of folk performance. If a live demonstration or an audio-visual projection is ongoing, this is where one shall experience the collective joy of music. The circular seating, the presence of instruments on display, and perhaps ambient recordings of distant folk songs at low volume shall resonate Hason Raja's cultural impact. The visitor's senses can be engaged openly, they can look up at the sky, feel the breeze, and hear echoes. This situates them in the same environment the poet would have experienced.

The visitor might browse a digital catalogue of Hason's songs at a listening station, read about the meaning of his lyrics on the interpretation wall, or view artifacts. The experience shifts from the extroverted to a contemplative but informational mode. In the design narrative, this layer corresponds to memories of Hason Raja's works as a documented legacy. It also reflects the broader cultural memory of Bengal; one section of the exhibit connects Hason to predecessors like Lalou Shah and successors like Shah Abdul Karim, situating him in a continuum. As visitors meander through these exhibit spaces, they construct an intellectual and emotional memory palace of Bengali folk music. The layering is also temporal; one space might emphasize the historic layer, while another highlights the present layer. By the end of this layer, the visitor has accumulated a wealth of impressions, sounds, and facts—effectively immersing them in the collective memory of the culture.

After absorbing the richness of the music and its context, now the design deliberately strips away stimuli, encouraging introspection. The transition might be orchestrated by a gradual narrowing of space, almost like entering a sanctum. A subtle sound installation—for instance, a low hum or the sound of a river—creates a meditative soundscape. The visitor is invited to sit, and contemplate. This layer symbolizes Hason Raja's own spiritual awakening as he wrote, “Lokey bole bole re ghor-barī bhālā nāy āmār...” – “People say my home is not splendid; what home can I build in this empty world?” expressing the ephemerality of material life. It is akin to the experience of standing in a humble hut or majhar (mausoleum) where silence speaks louder than words. In museum design terms, this is the emotional core, a quiet, reflective space. As visitors sit in silence, the layers of sound and information they gathered start to settle into memory. Many might recall a melody they heard earlier or reflect on the lyrics' meaning in their own life. By physically slowing down and internalizing, they partake in the intangible heritage in its most introspective form: spiritual contemplation.

Exiting into the daylight of the outside world, the hope is that visitors carry with them a deepened appreciation of Hason Raja's musical and spiritual legacy, having literally walked through it layer by layer. In effect, the museum experience is a microcosm of cultural transmission: it transforms passive spectators into active participants who have sung along, listened deeply, and pondered quietly, much as one would do in the actual practice of folk traditions.

International and Regional Examples: Fado Museum (Portugal) has an itinerary to guide you from the origins of Fado to contemporary interpretations, combining audiovisual stations and artifacts. (Castelo-Branco & Sánchez-Fuarros, 2023). The Paço do Frevo in Brazil integrates exhibition spaces with studios and dance halls, allowing visitors to both observe and participate, thereby bridging memory and living practice. (Lupo, 2021). This study generates a conservation strategy through which a museum is not a one-dimensional display of relics but a multi-layered environment where learning, experience, performance, and contemplation are all part of the journey.

Discussion

The conservation design and strategy of adaptive reuse focus on several critical aspects, including philosophical alignment of the house with Hason Raja's mystic philosophy. The tension between authenticity and change and the emotional attachment is expressed with its regional impact and future possibilities for engaging folk artists and young practitioners. Thus, adaptive reuse preserves both the tangible and intangible cultural heritage of the site.

Philosophical Alignment: Hason Raja's work reflects a deep philosophical connection to the divine and a quest for spiritual liberation. His songs focus on transcendence, love, and the oneness of existence. This insight must be embodied in the design of his residence-museum as a stage where visitors can experience not only Hason Raja's physical legacy but also his spiritual journey.

The design seeks layers of spaces that narrate his journey from worldly pleasures to spiritual enlightenment, aligning with his philosophical principles of interiority and mystical union that connect the philosophy of his music to the visitors.

Tension of Authenticity: The place itself holds cultural and spiritual significance, as with Hason Raja's residence. Now the question arises: how much change is too much? Here not only the physical fabric but also the spiritual and emotional attachment that people feel toward it add to its authenticity.

According to the conservation principles of ICOMOS and UNESCO, heritage preservation must maintain the integrity of the original form while also enabling it to serve new purposes. Here the aim is to preserve its historical features and original layout while introducing new elements that enhance its function as a cultural centre and museum.

User Perception: The success of the adaptive reuse project lies in the emotional attachment that visitors feel toward Hason Raja's house and their perception of Hason Raja's philosophy through this experiential journey. Interviews with local musicians, visitors, and community members show that Hason Raja's residence holds profound cultural significance. One musician interviewed stated, "Even though the house is falling apart, it still feels as if Hason is here, singing his songs." Such sentiments underscore the emotional resonance that the house holds for the local community as a living Bengali folk music heritage.

Regional Impact: While national figures such as Rabindranath Tagore receive substantial attention in heritage discussions, regional figures like Hason Raja often lack the same recognition. This shall hence serve as a template for similar projects focused on local cultural icons whose contributions to music, philosophy, and spiritual life have shaped regional identity.

Future Possibilities: Engaging local folk artists and young practitioners, the space will keep the museum alive, rather than a static archive. The programs include musical workshops, festivals, poetry recitations, and temporary residence for enthusiasts or artists. These initiatives integrate living traditions into the space, making the place a cultural incubator where the legacy of Hason Raja is both honoured and actively practiced.

Conclusion

The adaptive reuse of Hason Raja's residence is an important contribution to the preservation of intangible Bengali folk music heritage. It transforms the house into a dynamic space for cultural practice and spiritual reflection, offering an innovative approach to memory preservation that respects both the historical significance of the site and the living traditions embodied in it.

Besides, this acts as a stage for continued practice of his music and mysticism, highlighting the potential of architecture to encompass cultural memory. It allows heritage to be an experience through active engagement with the traditions that gives the static a meaning of life.

The project blends mysticism, music, and architecture, honouring both local traditions and modern needs. Thus, it acts as a model for preserving intangible cultural heritage through architectural storytelling. Here, adaptive reuse goes beyond merely preserving the physical fabric to honouring and extending the legacy of the cultural figures associated with it. The success of this project will depend strictly on how the community and future generations engage in the active conservation and performance of Hason Raja's legacy, ensuring that his contributions to Bengali culture continue to thrive and evolve.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 13

Critics of the Adaptive Reuse of Parvin Etesami House in Tabriz, Iran

* Dr. Narmin Babazadeh Asbagh

Introduction

Tabriz is one of Iran's antique cities, enriched with gorgeous historic houses of the Qajar and Pahlavi eras. Parvin Etesami House is one of these beautiful houses in Iran that belonged to this famous Iranian poetess. This historic house is one of the attractive Pahlavi houses in the ancient neighbourhood of Tabriz, which has faced improper conservation and adaptive reuse. This article aims to introduce and criticise the inappropriate conservation process of this unique house in Tabriz. After a brief research on Tabriz, the conservation process of Parvin Etesami House is presented and comprehensively and critically evaluated. This historical research is based on a qualitative method and the author's observations. The results of this article can be useful for preservationists and conservationists in the field of cultural heritage, as well as architects and interior designers, in the restoration, repair, renovation, and design of historic contexts within ancient cities worldwide.

The first part of this article focuses on the historic city of Tabriz, while the second part explores the Sorkhab neighbourhood of Tabriz. The third part of the article is about Parvin Etesami House, including her biography and the conservation and restoration process of this building. The fourth part concerns the important events and description of operations, problems in the restoration process, and troubleshooting suggestions. The last part of the article is conclusions and suggestions for further implementations and similar projects.

Naming of Tabriz

The history of any settlement can be traced back to its naming because the names of individuals or the reasons for its creation are often reflected in the name of the settlement. In books, this city has been mentioned as "Tabermeis", "Tabpis", "Gabris", "Gazad", "Troa", "Tora", "Ghaza", "Shahestan", "Toresh", "Tops", "Torzh", "Davriz", "Dorzh", "D-E-Vorzh", "Termaxin", "Ganjak" and "Termaxia" and so on. The author of Mirat al-Bulandan also narrates this subject with some changes. Then he says that due to the proximity of "d" and "t", "Daruyzh" became "Taurizh" and little by little "Turiz". As the mixture of Arabic and foreign words reached a level of perfection, the Persian word "Zhay" became Arabic and remained in the common tongue as "Turiz". The vowels (waw) were changed to "ba", and they were called "Tabriz". Regarding the reason why this land was called Shahistan, the author of the book Aturpaktan writes: "They say that because it was the seat of the kings in the days of Tabriz, it was called Shahistan (Shah means king) and Shah-e-Astan or Shahistan" (Faghih, 1967, pp. 24-25). Karang also writes in this regard: "The word Tabriz has been mentioned by Arab geographers such as Samani, Yaqut Al-Hamawi, and Kasr-e-Rata, and by Iranian and Turkish geographers such as Hamdollah Mostofi, Kateb Chalabi, and by Roman, Armenian, and Russian historians such as Faust, Asulik, Vartan, and Khanikov, as "Tavrez", "Tavriz", "Tavres", and "Davrez". Elsewhere in his work, he believes: "Oliya Chalabi has considered the word Tabriz to mean "the one that spits and spins", and this name is related to the ancient volcanism of Mount Sahand" (Karang, 1972, pp. 1-2).

Nader Mirza Qajar writes in his book "History and Geography of the Imperial City of Tabriz" about the reason for naming this city: "Abu Saeed recorded Tabriz as Tebriz, and also the Chief Justice Ahmad Ibn Khallikan, in his history and the translation of Bani Mansur Mohammad Ibn Ahmad, known as Hafda, has pronounced it as Tabriz, and he is a skilled historian and critic because it is not clear to us why this name was given, we cannot say anything." In the aforementioned book, Jamal al-Din Faqih continues his speech on this matter as follows: "The ancient capital of Azerbaijan was the city of Ganjak, in Takht-e-Suleiman, southeast of Maragheh. The Arabs called it "Kazana" and the Greeks called it "Gazza" (Nader Mirza Qajar, 1988, pp. 11, 15). Minorsky writes in his book "History of Tabriz", translated by Kareng: "Rawlinson, in an article, reminds us that one should not confuse the word Tabriz with the

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How to Cite This Chapter:

Babazadeh Asbagh, N. (2025). Critics of the adaptive reuse of Parvin Etesami House in Tabriz, Iran. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 149–165). Cinius Yayınları.

<https://doi.org/10.38027/N13ICCAUA2025EN0519>

genus "Ganza", which is the city of Shiz." The same author adds: "It should be noted that the name Thebarmais should not be confused with the name TAVREZ, because Thebarmais was a city east of Genzca (Genzke), and in 623 AD, after destroying Genzca, the Roman Emperor Heraclius burned the city of Thebarmais and its fire temple" (Minorsky, 1958, pp. 8-9). For more information about the city of Tabriz, the bachelor's thesis of the author entitled "Hostel of Quri-Gol Tourist-Entertainment Complex (Tabriz)" (Babazadeh-Asbagh, 2007), and the relevant article derived from it titled "Designing a Hostel in the Touristic Complex of Quri-Gol Lake near Tabriz, Iran" can be read (Babazadeh-Asbagh, 2022b, pp. 134-150).

Mansion of Tabriz

There has been much talk about the founders and builders of this city in the school of the ancients, and examples are provided for familiarisation in this regard. Nader Mirza Qajar opens his speech on this subject as follows: "It is written in ancient letters that the Azarabad people were freed by the Parthians until Ardashir killed Ardavan, the Parthian king, and added Azerbaijan to his kingdom, which occurred in the year 226 AD. After a short time, Khosrow Kabir captured that kingdom from Ardashir-e Sassanid and built the city of Daruyzh in the year 253 AD" (Nader Mirza Qajar, 1988, p. 286). The author of the book "History of Iran during the Qajar Period" writes: "The city of Tabriz, the capital of the country of Azerbaijan, is the place where Kaykhusrow had collected the property of King Croesus of Asia Minor after conquering that country." (Markham, 1970, p. 57). In the book "History of Azerbaijan", translated by Dr. Ishaq Bayat, a professor of philosophy and history, without mentioning the old name of this city during the Sassanid dynasty, it is stated: "The Sassanid dynasty, which came to power in 224 AD, occupied Atropaten. The successor of the Sassanids was the city of Tabriz. Zoroastrianism was the official religion of the Sassanids and became the official religion of the country in the late fourth century" (Qoliof, 1988, p. 58). The Byzantine historian Photius writes about this war (the last conflict between Sassanid Persia and Armenia): "During the reign of Arshak II, the king of Armenia (347-351 AD), the Armenian general Vasak attacked the camp of Shahpour II, the Sassanid, located in Thavrez, and "killed the Iranian general Boykan, set fire to the royal palace, and threw an axe at the statue of the Shahenshah that had been erected there, and then Mushegh, the son of Vasak, defeated the Iranian army in Tabriz" (Minorsky, 1958, pp. 8-9).

Using the book "History of Tabriz" written by Minorsky, Khanlou deduces the following: "According to Minorsky, the Arabs at that time, when they conquered Azerbaijan, noticed the conquest of Ardabil, and among the cities that formed the central core, or when the Azerbaijani border guard was gathering an army to confront the Arabs, no mention of Tabriz is made. To clarify whether the current Tabriz is one of the old cities of Azerbaijan and whether such a city with this name existed in ancient times or not, I have no choice but to admit that not only before Islam and the arrival of Arabs to Azerbaijan, but also for several years after the advent of Islam, there is no convincing evidence for the existence of such a city, or that, based on the indications at hand, which we will not ignore, we must accept that in very ancient times there was a city with this name in the land of Azerbaijan (Maad), then over time and due to the events of the times it was destroyed and disappeared." "It was destroyed, and its history has not reached us. Then, a very old and unknown castle or village remained from it. Later, they built another city called either Aman or Abadan and gathered the people's help to make it a city, and that is also the city we are discussing now" (Khanlou, 1985, pp. 19-20).

Until the Khorramdinan uprising led by Babak in 201 AH, Tabriz was not mentioned, except in one or two places where Islamic historians (Tabari, Ibn al-Athir, Ibn Nadim) did not mention the name of Tabriz. The author of the dictionary of the Mirror of the Worlds, Yaqut Al-Hamawi, believes that Tabriz was initially a village, as can be inferred from Armenian sources and his Byzantine writings. Tabriz was inhabited and had the title of a city several centuries before Islam, around the fourth century AD. However, since Tabriz was not mentioned in the Arab attacks on Azerbaijan in 22 AH, it can be assumed that it was devastated by the end of the Sassanid period and was no longer a village. However, the geography textbooks of the East Azerbaijan province state that: "The history of Tabriz after its emergence is obvious. In 21 AH, when the Arabs conquered Iran, Tabriz was a small military fortress, but Ardabil was of great importance" (Educational Research and Planning Organisation, 1984, p. 20).

The opinion of Yaqut Al-Hamawi and Hamdullah Masoufi Qazwini regarding Tabriz is ambiguous. Yaqut Al-Hamawi and Hamdullah Masoufi Qazwini, and some other historians and travellers stated that Tabriz was founded by Zubeydeh Khatun, the wife of Harun al-Rashid, the Abbasid Caliph, according to two narrations. The first narration states that Zubeydeh Khatun had been suffering from fever for some time and was travelling to change the climate and find a place that suited her temperament, until she reached Azerbaijan. In the place where Tabriz is located, her fever stopped. Therefore, she founded a city there in 175 AH and said that since my fever stopped here, this city should be similar to Tabriz. She built a canal east of the city, which is known as the Zubeydeh Canal. The second narration is: Zubeydeh Khatun, the wife of Harun al-Rashid, the Abbasid Caliph, became seriously ill in 165 AH and was on the verge of death. At this time, a doctor from the people of (Maad) came to Dad Tui and healed the sick woman in a short time. The queen, who did not know how to reward the doctor, asked him to choose his reward. The doctor requested that Zubeydeh Khatun order a city to be built in his native country in his honour. This wish of the doctor (Maadi) was fulfilled with utmost precision and speed in the year 165 AH, and he named the newly built city Tabriz so that its emergence could be attributed to medicine. Because "TAB" means fever, and "RIZ" comes from pouring, which had the meaning of fine and conveys the idea of spreading (Khanlou, 1985, p. 22). Nader Mirza Qajar

writes about the authenticity of this story: "The relationship between the Tabriz mansion and Zubeydeh, as explained by the fact that she came here, has no basis" (Nader Mirza Qajar, 1988, p. 17; Tariqat, 2009, pp. 19-25). For more detailed information about the history of Tabriz city, an article written by the author entitled "A Short Glimpse to the Urban Development of Tabriz during the History" can be referred to (Babazadeh-Asbagh, 2019).

The Appearance of Iranian Cities in the Qajar Period

"The multitude of reports and evidence that travel writers and historians present from the cities of the Qajar period up to the year 1911 AD all prove that the appearance of the city in this period was no different from the appearance of the city in the eighth and ninth centuries, because the shape of the city is fundamentally affected by the social and economic order in which it is located, and this system, as we know, remained strong until this period. During this period, strong towers and ramparts were considered a sign of the greatness of the city. The bazaar was the heart of the city's economy, and within it, various guilds were organised in different orders, and within it, various associations were gathered in different orders. The ark was the administrative centre of the city, regulated all the social relations of the city, and even drafted laws in the city itself. In terms of general division, the city was divided into three main parts: Main Ark (the old fortress), the city (Sharistan), and Rabez (the core of the city). The mosque, in addition to fulfilling other functions, was considered the centre of the city's judicial system. The alleys were narrow and winding and were paved with stone, and the old caravanserais (inns) were still considered the main refuge for travellers. The city was divided into different neighbourhoods, and each neighbourhood had its mayor, who was appointed by the city governor. The policemen were responsible for the order of the city, and the sheriffs acted as a kind of mayor. In short, whether in appearance, economy, or social composition, it had the same form and function as the medieval city of Hak" (Azimi Dobakhri, 2015).

However, the constant appearance of the city, which had brought about a thousand changes, could no longer resist the onslaught of new elements of urbanisation. Because new manifestations of urbanisation began to blow like a storm from the West and to fulfil new social needs, cities changed their appearance. Modern and advanced communications increased the security of the city's people a hundredfold, and any place in the city could be a warehouse and a place to sell goods. Gas lighting and then electric lighting turned the dark and gloomy night of the city into the day, and finally, as modern Iranian men became more familiar with the West, they made more efforts to change the traditional urban buildings and appearance. This increasing influence of the West caused a new class called the "urban bourgeoisie" to emerge in the city, which later played a major role in bringing the feudal Qajar government to its knees in the Constitutional Revolution because this new class strongly desired changes in the state system and its cumbersome socio-economic relations. However, at first, this did not include all the cities of Iran. Rather, it included the big cities, first of all, Tehran and Tabriz. One of the fatal blows that classically struck the city during the Qajar period and was unique in the history of Iranian urbanisation was the creation of the telegraph wire in the mid-nineteenth century (last quarter of the thirteenth century AH). In addition to the telegraph wire, the establishment and restoration of the free road also had an important impact on the appearance of the cities. The old Iranian trade caravan road could no longer carry the flood of European goods. The carriage, in turn, after it became popular, necessitated wide, paved streets (Atazadeh, 2004, pp. 13-14).

Tabriz in the Qajar Period

The year 1193 AH is the beginning of the Qajar dynasty and coincides with the last, in other words, the heaviest and most devastating earthquake in Tabriz. Since this earthquake occurred on the last night of the year and continued for some time, it is sometimes referred to in various chronicles as the earthquake of the year 1194 AH. The chaos and lack of a strong central government caused Tabriz to remain under the rule of local rulers this year and for a few years after that. At this time, Tabriz was ruled by the followers who, after the conquest of Azerbaijan by Agha Mohammad Khan-e Qajar in the year 1205 AH, continued to represent the central government in Azerbaijan and Tabriz. In Riyadh Al-Jannah, it is stated about the earthquake of 1193 AH: "All the high buildings and fortified monuments of schools, mosques, passages, buildings and bridges were destroyed in a single day, including the Ghazan Monastery, the Saheb Ol-Amr Mosque, the Jahan Shah Mosque, the Jame Mosque, the Seyyed Hamzeh School, the Sadeghieh School (Madreseye Sadeghieh), and the Talebieh School (Madreseye Talebieh), none of which had been seen by the camera on the entire earth. All of them were destroyed, and without exaggeration, not a wall of a single span was left." The size of the city in subsequent reports and quotes supports this issue. Nader Mirza Qajar reports the city's population at the beginning of Mohammad Khan-e Qajar's reign as 4,030, and John MacDonald Kinneer, an English traveller who was in Tabriz in 1216 AH, wrote that the city's population was 30,000.

The rebuilding of the city began again by the people following this extensive destruction and damage, and with the re-formation of the city, the construction of a new or last rampart of the city began and was completed around 1224 AH by Najaf Qoli Khani Donbali. In 1241 AH, Abbas Mirza built a moat around this rampart, and it was this year that Tabriz became the crown prince's residence and the second-largest city in the country, from a political point of view, it became one of the main centres of decision-making, to the point that British and Russian delegations often stayed in this city. The speed of the city's construction during this period was such that in a very short time, it had demolished its last rampart, and the houses were called the old ones, but with a new perception of housing. The

market regained its original core in more or less the same place as before. It expanded as the city's political prestige increased, which was followed by its economic stability. Many of the old buildings, such as the Saheb Ol-Amr Mosque and the Talebieh School, were restored or rebuilt. In contrast, new buildings were constructed with a fresh architectural perspective, serving as government offices. It was strongly emphasised that the re-formation of the city should be based on the same old texture that remained from the ruins, and therefore what is now the legacy of the city's past is the product of the Ghazani period in terms of texture, important historical movements, and valuable poles, and in terms of housing architecture, it is the product of the Qajar period, which later underwent major changes in the Pahlavi period. However, what shapes the historical area of the city around Tabriz Bazaar is still the result of both mentioned monuments (Zokaa, 1989).

To understand this period of Tabriz's history, it is necessary to be aware of the developments that occurred in the world during the aforementioned period. The First World War broke out during this period, and the great transformation of weapons, along with the transformation of communications, established the strength of countries not based on the size of their reserves but on other criteria. The Industrial Revolution, the Great French Revolution, and the Russian Revolution also took place during this period. The Ottoman Empire's invasion and the formation of the Soviet government, both of which were threats to Tabriz, and the consolidation of Tabriz's position as the crown prince's residence and the most important city, led to political decisions. During this period, Tabriz was once again the country's main gateway to Europe and the New World. This situation led to many new achievements of the New World being experienced in this city, including the first printing house, with its great cultural effects and consequences. The many visits and contacts with Europe and the northern neighbour, in addition to all the effects it left in political, cultural, and social aspects, had profound effects on the architecture and urban planning of the city, which, due to its nature, became more intense and strong in later periods. Among the noteworthy events in this period is the conversion of the Ark-e Ali-Shah Mosque into an armoury or arsenal by Abbas Mirza, and it is most likely from this period that the Ali-Shah Mosque is mentioned as the Ark-e Ali-Shah Mosque in many writings (Atazadeh, 2004, pp. 15-17). For more information about the architectural characteristics of the Qajarid houses in Tabriz, the article entitled "Comparative Analysis of Qajar Historic Houses in Tabriz, Isfahan, Yazd, and Kashan, Regarding their Architectural Forms and Elements", written by the author can be studied (Babazadeh-Asbagh, 2022a, pp. 586-605).

Tabriz in the Pahlavi Period

During the reign of Reza Khan, Tabriz, like most cities in Iran, began to take shape as a modern urban planning system, the first example of which was the construction of wide streets, which followed the arrival of automobiles to Iran from abroad. The first street in Tabriz was Pahlavi Street (renamed to Imam Khomeini Street after the revolution of 1979), which was built between 1921 and 1926 by order of Abdollah Khan Tahmasbi, commander of the Azerbaijani army. This street separated the Ark-e Ali-Shah Mosque from the main city core and the bazaar. With the construction of Pahlavi Street, which continued from around Qutb Square (Qord Meidani) to Qonqa Square (Qonqa Bashi), the old Tabriz Street, which passed in front of the entrance of the Blue Mosque (Qoy Masjidi), lost its prosperity. Pahlavi Street passed right behind the Blue Mosque (Qoy Masjidi). In 1928, Mohammad Ali Tarbiyat, the then mayor of Tabriz, laid the foundation for the second modern street of Tabriz by constructing a street that connected the Nobar neighbourhood to the main core of the bazaar. This street also destroyed a large part of the Tabriz bazaar. Because it split the southern part of the bazaar. During the time of Mohammad Ali Tarbiyat, the Streets of South Shahpour, Ferdowsi, Monajjem, Khaghani, and Mansour were built between 1928 and 1931. South Shahpour Street crossed the eastern part of Darb-e Khiyaban, Monjem crossed the western part of Darb-e Gajil, and Khaghani crossed the eastern part of Darb-e Khiyaban and reached Daneshsara Square. Mansour Street, although outside the ramparts, completely split the fabric of the Mansour neighbourhood and reached Mehran Rood (River). Shah Bakhti Street (renamed to Islamic Republic Street after the revolution of 1979) was built in late 1930 and early 1932, which completely split the main central core of the bazaar into two. This street connects the beginning of Ferdowsi Street to the beginning of South Shahpour Street.

In 1941-1945, due to World War II and its consequences, construction and urbanisation in Tabriz, like most cities, were halted. In the early 1950s and during the reign of Mohammad Reza Pahlavi, Shahnaz Street (renamed to Shariyati Street after the revolution of 1979) was opened from the Leilavar location to the North, and its Southern part advanced to the Mahad-Mahin Gate, drastically changing the texture of that area. Darayi Street was extended from Shah Bakhti Street to the Southern bank of Chay Square, and Khaghani Street was extended North of the river, called Seqqat Ol-Islam, to the central parts of the Sorkhab neighbourhood. In 1958, Shams Tabrizi Street, which is considered the Northernmost East-West Street, connected Seqqat Ol-Islam Street to the bridge and Monajjem Square by passing through the Shotorban neighbourhood. At the same time, Mellal-Mottahed Street was also connected to Shams Tabrizi Street from the Northeastern corner of Bagh-e Golestan Square, and the Gajil Gate was destroyed at this time for no reason and due to the inattention of the authorities. Since the early 1960s, with the country's internal affairs being put in order, the situation of Tabriz has also changed, and the city has rapidly turned towards development and industrialisation, and huge university buildings, machine-building, tractor-building, diesel-building, and new water and electricity facilities and other factories have been built there, and even now its population and beauty are increasing day by day (Omrani & Esmaeili, 2006, pp. 88-110). For obtaining more

information about the historic houses in Tabriz, another article written by the author entitled "Adaptive Reuse of the House of Mirza Mehdi Farrashbashi in Tabriz, Iran" can be read (Babazadeh-Asbagh, 2021, June, pp. 506-520) and the relevant video can be watched on the YouTube channel of the author (Babazadeh-Asbagh, 2021, May 14).

Sorkhab Neighbourhood in Tabriz

This name is an adjective and adverb composed of "sorkh" (red) and "ab" (water), and originally meant having a red colour and water. The word has several meanings, including a type of duck that is red. In the oldest Persian dictionary, namely, the dictionary of Fars Asadi, the meaning of Sorkhab is a red bird, and in another meaning, a flower that women use for decoration. One of the meanings of Sorkhab, as listed in dictionaries, is the name of both people and places, with one of these being a famous location. Also, from the meanings of Sorkhab, one is written as the name of Rostam's son (Sohrab), and we know that Sorkhab and Sohrab are the same, because Suhrab = Sorkhab; Surzab from Suhrab = red + water, meaning the possessor of water and red colour (like ruby or wine) (Ziyari, 1992, p. 313). In the Tabaristan dynasty, two people were written as Sorkhab and one as Sohrab (Bavandi, 1938, p. 10). In the Dictionary of Anandraj (Farhang-e Ānandrāj), it is written: "Another name of Rostam's son who became famous as Sohrab and followed by the poem of Salman Savji, who took Sorkhab to mean wine and with Sorkhab (= Sohrab) he has brought the son of Rostam in the form of an allegory. On this occasion, in the dictionary of Shahnameh, compiled by Dr. Shafaq, under Sorkhab, it is written: The name of an Iranian from the time of Yazdgerd, ab here means radiation, and Sohrab also has the same meaning; that is, radiation and red glow, Mehrab also means with the glow of the sun. Sorkhab is also the name of a place, including the name of the northern part of Tabriz and the name of the mountain range in the north of that city" (Farhang-e Ānandrāj, 1888-1889).

In the dictionary of the story of Jam, it is also written: (Sukhor, Sohr) Surkh. From this root are Sur and Sohr in Sohrab. In the story of Rostam and Sohrab, the correction of Professor Mojtaba Minovi, while preferring the version of the Badals, it is written that in the Mab (a version in the British Museum), in the entire story, Sorkhab was almost all carved and transformed into Sohrab. In the dictionary of Fars Asadi, it is also written: You said that the whole plain was Sorkhab. In the margin: Sohrab is written in the notes of the Goths of Puru David, after explaining the word Sokhor, which is called Sukhor in Pahlavi and Persian Sohrkh. It is stated: The name Sohrab = Sorkhab, meaning, possessing a red or reddish hue. This sameness of the names Sohrab and Sorkhab caused Hafez Hussein Karbala'i to write in his book "Rawdat al-Jinan wa Jannat al-Jinan" about the name of the Sorkhab neighbourhood: The Tomb and Grave of Sohrab, one of the companions, is in Sorkhab, next to Baba Hassan. First, one of the companions is in his Sorkhab cemetery, and that is why it became Sohrab and then Sorkhab (Karbala'i, N. D.).

Apart from the name Sohrab, son of Rostam, several other famous names have been mentioned in the records as "Sorkhab", including Sorkhab Bin Qarn, the king of Kiyoshi (died 466 AH). Sorkhab Bin Mehr Mardan was the king of Kiyoshi, and the king known as Sorkhabiyeh was from the Zaydi sect, also known as Khashabiyeh (Eghbal Ashtiyani, 1979, p. 255), recorded in Al-Khwarizmi's Mafatih Al-Uloom "Sorkhabiya" and "Sorkhab Tabzari" (Al-Khwārizmī, 975-997, p. 34). Sorkhab Bin Badrgerd (Siyaghi, 1957) was one of the rulers of Dinwar and the cities of Zur and Jistan, whom Tughrul Beig Seljuq gave rule in Baghdad. It is possible that in the joint selection of Yaqut Al-Hamawi, he wrote about "Khifyatan" (Yaqut Al-Hamawi, 1984, p. 74), "Khfatizkan". "There are two castles in the areas of Erbil and the other castle is called Khiftian Sorkhab son of Badr, and it is on the way to the city of Zur and is larger than the first." It is attributed to this Sorkhab Ibn Badr (In the History of the Worlds, published in Tehran) "Sorkhab Ibn Badr Ibn Mushalhal, his death was recorded in the year 500 AH, and the name of the castle was "Haqidkan" (Fernández-Armesto, 2014, p. 1660), and in the summary of the stories it is stated: (Malik Al-Shu'ara Bahar, 1935, p. 410) "Saif al-Dawla Sadqa Ibn Mazyd, the Arab prince, rebelled against Sorkhab Daylam and Sorkhab was captured and they were prevented from entering the castle of Tikrit." In the Shahnameh (Ferdowsi), the name of Afrasiab's son is "Sorkheh", which is also written as "Sorkhab" in dictionaries (Siyaghi, 1957). In some histories, such as the History of Jahan Ara (Qazvini, 1567), the names of several kings and princes are mentioned as "Sorkhab", including: "Sorkhab from the king of Tabaristan, the son of Wallash", "Sorkhab Ibn Mehr Mardan" (Hafez Bookstore, p. 175), and "Sorkhab and Mazyar", the sons of Qarn (Hafez Bookstore, p. 176), and one of the sons of Jamasb Ibn Firuz, the uncle of Anushirvan, is also named "Sorkhab" and writes: (Hafez Bookstore, p. 181) "He was content with the province of Shirvan, and according to the legend of the king's grandfather, he is there." The names of several kings of Bavand in the history of Tabaristan are "Sohrab" and "Sorkhab" (Abbas Eqbal, p. 20). For detailed information about the Sorkhab Neighbourhood in Tabriz, the master's thesis of the author entitled "The Conservation and Revitalisation of Mirza Mehdi Farashbashi's House in Tabriz" can be studied (Babazadeh-Asbagh, 2011).

Biography of Parvin Etesami

Rakhshandeh Etesami (E'tesami), known as Parvin Etesami, is an Iranian poetess. She is considered the greatest Iranian poetess ever. Parvin Etesami was born on 17 March 1907 in Tabriz. Her mother, Akhtar Fotohi, who was from Azerbaijan, passed away in 1973. Her father, Mirza Yussef Etesami Ashtiani (Etesam-Ol-Molk), was from Shaft and originally from Ashtiyani. Parvin's father, Etesam-Ol-Molk, was a writer and activist during the Constitutional Era and immigrated to Tehran from Rasht with his family in 1912. Parvin's grandfather, Mirza

Ebrahim Khan Mostowfi Etesam-Ol-Molk, was originally from Ashtiyan but moved to Tabriz and was appointed financial controller of the province of Azerbaijan by the Qajar administration. Parvin was the only daughter in her family, along with four other brothers. Her family moved to Tehran early in her life, and in addition to formal schooling, she obtained a solid understanding of Arabic and classical Persian literature from her father. As a child, she learned Persian and Arabic under the supervision of private tutors at home and English at the American School. Parvin began her poetry career at the young age of eight and studied at the Iran Bethel School, an American Girls College in Tehran, where she graduated in 1924. For her graduation, she wrote the poem "A Twig of a Wish", about the struggles of Iranian women, their limited opportunities, and the need for their education. Afterwards, she taught for a while at that school. In 1926, she received an invitation to become the tutor of the Queen of the new Pahlavi court, but she refused. At the age of 28, Parvin married her father's cousin, Fazlollah Etesami Ashtiani, then head of the Kermanshah police, on 10 July 1934, and four months after their engagement and marriage, they moved to Kermanshah. This marriage ended in divorce on 5 August 1935 due to cultural incompatibility between the couple, and Parvin never spoke about this unsuccessful marriage until the end of her life. Parvin's brother, Abolfath Etesami, cited the reason for this separation as mentality and ethical differences between the two, stating that Parvin's gentle and free-spirited nature was incompatible with her husband's military mindset.

It was during these years that she worked as a librarian in the library of the Higher Educational Institution. Parvin became acquainted with constitutionalists and cultural figures from a young age and studied literature with his father and teachers such as Dehkhoda and Malik Al-Shu'ara Bahar. With the encouragement of Malik Al-Shu'ara Bahar, this poetess published her *Divan* (book of poems) in 1936, which includes 248 poems, of which 65 are in the form of debates. Parvin Etesami's poems are primarily literary pieces that explore social themes with a critical perspective. Parvin is considered the greatest Persian poetess of the Persian classical style. Loneliness and seclusion from social activities - the lot of almost all Iranian women in her day had the same issues- added to the sad experiences of a sensitive and tender soul and made her the most sincere voice of the cruelty of the rulers and wealthy landlords. She knew of the corruption of the leading authorities in the judiciary and the clergy. Her work reflects the reality of life in her day and offers moral solutions. Although her technique in poetry is unquestionable, Etesami's language is at times archaic, and she very much seems to be out of touch with the realities of modern life. She mostly repeated the clichés of Persian traditional poetry as the subjects of her poems. This can be traced to her private education at home with her father, which meant that although she received a first-class education, she was almost completely protected from the world outside. This shelter broke when she married and had to live for a while in another city. The shock of the outside world was too much for her delicate self to handle, and she divorced and died soon afterwards.

Her father died in 1938, and her father's death at the age of 63 dealt another terrible blow to her sensitive soul, the depth of which can be felt in the elegy she composed in mourning for her father: "Father, the axe that struck your soil was the axe that destroyed me". Three years later, Parvin Etesami eventually died due to typhoid fever at the age of 35 on 5 April 1941 in Tehran and was buried in the shrine of Hazrat Masoumeh in Qom in her family tomb near her father. Although she had a short life, she became famous after her works were published, and she managed to achieve great fame amongst Iranians in her short life. She was well respected in all circles of life, not just because of her brilliant and revolutionary works, but for her refined manners and the free spirit that she possessed. She developed a style for expressing people's pain by making comparisons to natural events. The political events in Iran had a great influence on her way of writing. One of her remarkable poems, called "Drunk but Aware", won the admiration of everyone involved in romantic poetry in Iran. Her poems can be divided into two categories: the first category is written in the Khorasani style and includes advice and is more similar to the poems of Naser Khosrow. The second category is written in the Iraqi style and is more of a narrative aspect, especially in the form of debates, and is close to the style of Saadi's poetry.

Parvin Etesami, a renowned contemporary poet, is one of the prominent figures among female poets across all historical periods. Parvin's classical poetry is complete and exemplary in both general aspects of poetry, content and form. Parvin has presented complex philosophical views and socially relevant issues in the most beautiful and heartwarming formats in the content of her poetry. Parvin's symbolic poems, in which she has used elements of nature, animals, inanimate objects, and other phenomena to express her meaning, are among the methods that, although not new, are very successful. Parvin's poetry is the poetry of human pain, philosophical pain and social pain of humans. There is hardly anyone who does not know Parvin Etesami, the poetess of our century, and is not familiar with her works, especially those who are interested in poetry, who have complete and utter devotion to this wonder of the city, literature, and mysticism. The fertile literature and mysticism of Iran have given us many geniuses among men, but among women in this field, we have not yet come across anyone who has reached the literary stature and status of Parvin Etesami. If we study the history of literature carefully, we will come across women poets such as Rabia Bint Ka'ab, Mahasti Ganjavi, Zeb-Un-Nissa (Makhfi), Laleh Khatun, and several others, and recently, several Qajar women who have contributed works to our literature in the field of poetry.

However, Parvin Etesami should be considered the only shining star of Iranian women's literature, and she is the one who shines like a bright star above the gloom of all Iranian women poets. Any reader who carefully studies Parvin Etesami's intellectual poems will be well acquainted with the spirit of this lady. The mystic realises the literary and throughout her works, there is not even a single word that is outside the boundaries of morality and humanity. By reading her works, the reader encounters a compassionate teacher who, with advice and counsel,

shows them the dark path of life with the light of knowledge, science, and literature, and teaches them the introduction to Allah, and this is one of the characteristics of Parvin Etesami's poems. Parvin Etesami does not consider anything better for the female class than chastity and purity, and she has made many efforts in this direction. Most of Parvin Etesami's works are mystical, but they are not devoid of pure feminine feelings, and in her poems, we encounter so many conversations about thread and needle, garlic and onion, lentils and mung beans, pots, and jars, etc., that in the end, the same result that the poetess wanted is conveyed to the reader.

Parvin considers herself indebted to the upbringing and guidance of her esteemed father, Yousef Etesami (Etesam-Ol-Molk), who is one of the renowned scholars and writers of the last century. Yousef Etesami, Parvin's father, has contributed numerous literary works to Iranian literature, including his writings and translations, the most famous of which is the publication of the twenty-four-volume collection (*Bahar*). Parvin Etesami's biography states that this accomplished lady, with her innate genius, began composing poetry at the age of eight, and with the guidance of her literary father, she continued composing poetry until the end of her life. Parvin's tomb is located in her family's tomb, and a poem she wrote for her tombstone is engraved on it. In a word, Parvin Etesami is a perfect model of an Iranian Muslim woman, whose words and behaviour can be a guide for all women (Babaei, 1997, pp. 3-4).

House of Parvin Etesami in Tabriz

Parvin Etesami was one of the most prominent Persian poets of the 20th century, born in this house in Tabriz. This house belongs to Yousef Etesam-Ol-Molk, the father of Parvin Etesam, and is located in the Sheshgela neighbourhood of Tabriz. This two-story house was purchased by the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan and is used as a museum of Parvin and her father's works, after restoration and reconstruction. Parvin Etesami's house became an Iranian national heritage site on 19 October 2006 (Pour-Hussein Khoneigh, 2005). Parvin Etesami was a talented genius of Iranian literary history who wrote more than 5,600 lines of poetry in her short life. Four thousand works compete in Iran's largest literary award for women Culture and Art Group. More than 4,000 works have been sent to the secretariat of the third edition of the Parvin Etesami Literary Award, and the judging of the first stage of this award will end soon. Ali Shojaei Saein, CEO of the Book House (the institution organising the Parvin Etesami Literary Award), said: "Once the judging is complete, we will hold this award in the first half of March, during a ceremony for which initial planning is underway." According to this official, each of the winners of the third edition of the Parvin Etesami Literary Award will be awarded 22 coins. He expressed hope that the Book House, in cooperation with institutions involved in women's issues, will hold the Parvin Etesami Literary Award on a larger scale in the coming years. The Parvin Etesami Award, with the aim of "creating suitable conditions for the growth and advancement of women", is held every two years in two areas: translation and writing in the fields of poetry, fiction, dramatic literature, children's literature, and literary research. The members of the Board of Trustees of this award are the Minister of Culture and Islamic Guidance (Chairman of the Board of Trustees), a member of the Persian Language and Literature Academy elected by the Academy, and representatives of the Ministries of Culture and Islamic Guidance, Science, Research and Technology, Education, and the Iranian Broadcasting Organisation in the Women's Cultural and Social Council (Jame-Jam Newspaper, Tuesday, January 10, 2008, Year 9, Issue 2465, p. 16).

Conservation of Parvin Etesami House

The reconstruction of Parvin Etesami's house in Tabriz began with the purchase of the house from a private owner and the allocation of credit. The reconstruction and restoration of Parvin Etesami's house in Tabriz was completed by the end of 2010. Dr. Behrouz Omrani, Deputy Director of the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan, stated (2008): "The completion of the reconstruction of Parvin Etesami's house will be achieved on the condition that the allocation of necessary credits continues next year." Stating that 500 million rials have been spent on the reconstruction of Parvin's house so far, he continued: "According to estimates, a credit of one billion and 500 million (Iranian) Rials will be needed to complete the reconstruction of this building under current conditions." Omrani, referring to the problems of securing credit in previous years for the purchase of this historical house, added: "The credit for the purchase of the house of the famous Iranian poetess in Tabriz was finally secured with the visit of the President to East Azerbaijan last year (2007)." The deputy head of the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan reminded that: "From the funds approved by the presidential visit, an amount of more than four billion rials was allocated for the purchase of Parvin Etesami House."

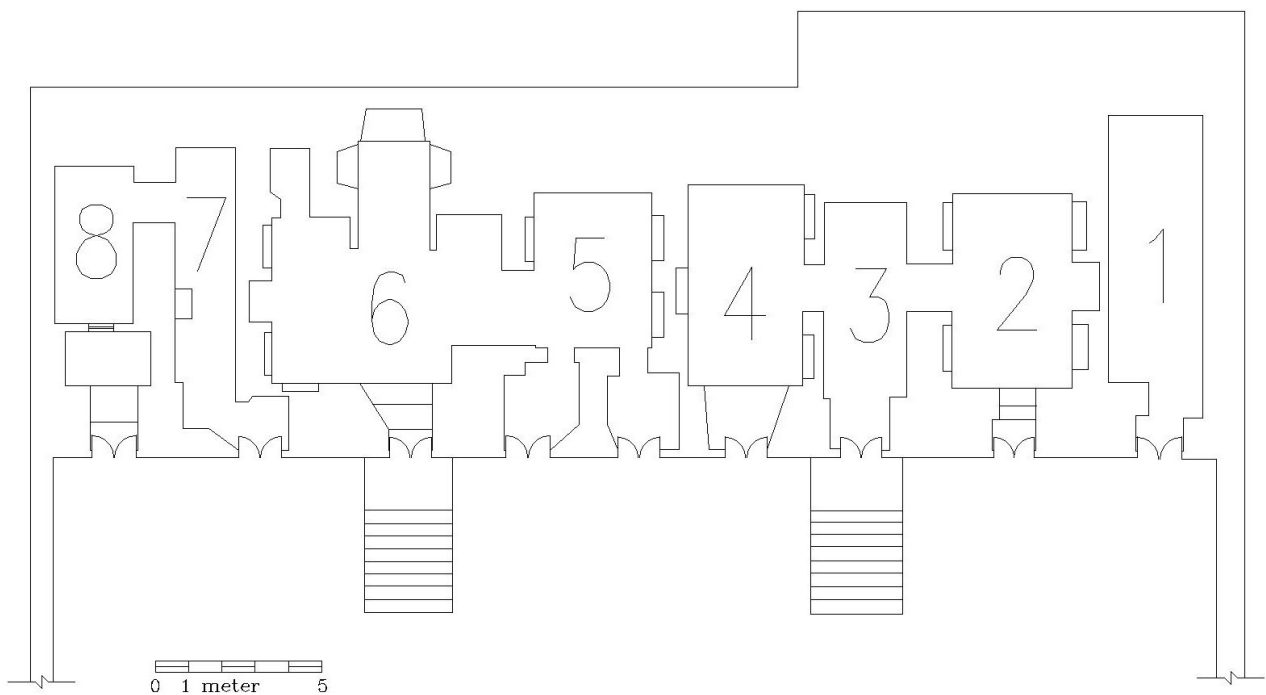


Figure 1. The Plan of the Basement of Parvin Etesami House (Developed by the Author).

He said: "After the required funds were allocated, negotiations began with the private owner of the building, and finally, Parvin Etesami House became the property of the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan in May of this year (2008)." Behrouz Omrani noted: "For the reconstruction of Parvin Etesami House to be completed by the end of next year (2009), the allocation of funds should continue from April 2008." Meanwhile, Engineer Nasim Alipour, responsible for the reconstruction project of Parvin Etesami House, said: "Given the very poor condition of Parvin Etesami House, as soon as the place was taken over, emergency conservation operations for the building began in June of this year (2008). After the emergency conservation operation, the strengthening phase of this house has begun, and its implementation operation continues under the supervision of the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan." This expert on the reconstruction of historical buildings said about the characteristics of Parvin Etesami House: "The total area of this property is 1,690 square meters, and the foundation of the house is 760 square meters. According to the person in charge of the reconstruction project of Parvin Etesami House, it is built on two floors and has 14 rooms" (See **Figure 1 & Figure 2**).

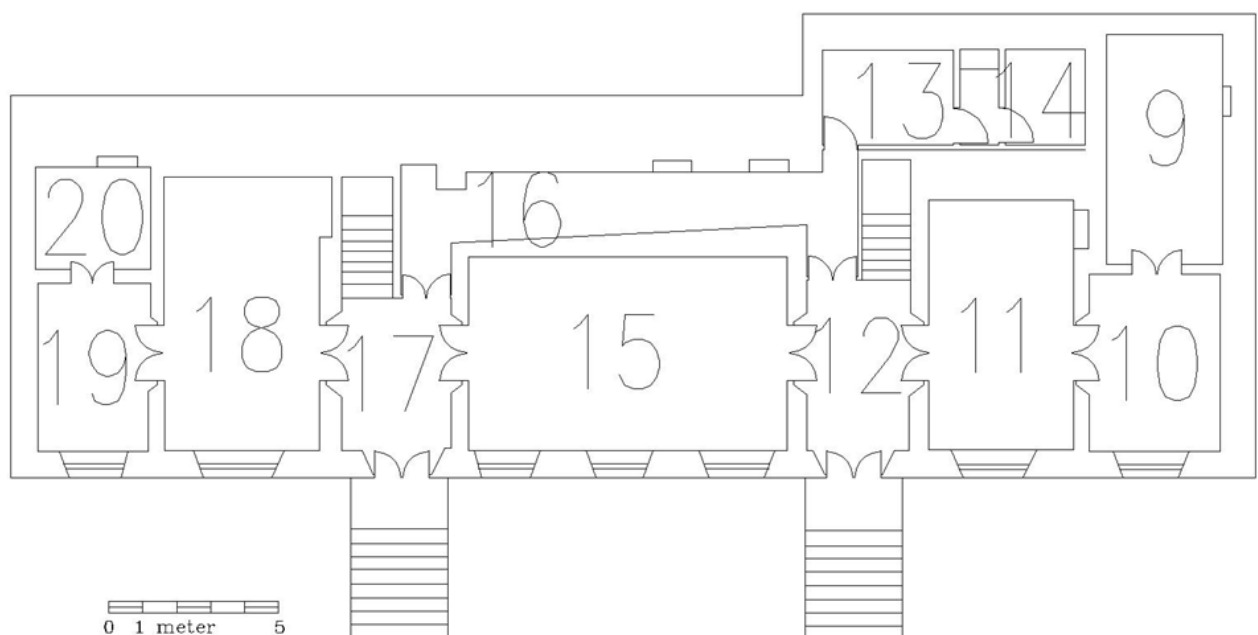


Figure 2. The Plan of the First Floor of Parvin Etesami House (Developed by the Author).

Engineer Nasim Alipour noted the age and characteristics of this building: “The age of the Parvin Etesami House dates back to the first Pahlavi period and carries the architectural characteristics of this period, but this building has great spiritual value considering the residence of the most famous poetess of Iran.” Khodavardi Karimi Nejad, head of the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan, referring to the abundance of historical houses in the old city of Tabriz, said: “So far, 500 historical houses have been identified in the city of Tabriz, and based on the evaluation of experts from this organisation, 296 buildings have architectural and historical value.” He noted: “Considering the abundance of historical houses in Tabriz, however, only 31 buildings have been purchased and renovated by the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan.” Karimi Nejad stated that the organisation's budget for all its activities is only 30 billion (Iranian) Rials per year, adding: “Given that, due to credit constraints, this organisation can acquire two to three houses per year, the purchase of the aforementioned houses will take 100 years.” The head of the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan emphasised the need for cooperation between the private sector and other non-governmental organisations in purchasing historical houses in Tabriz, adding: “All over the world, the private sector and other urban institutions such as municipalities assist the government in purchasing and renovating historical houses. Otherwise, it will never be possible for this organisation to save the valuable historical monuments of this region alone” (Khoshkar Moghaddam, October 10, 2007, Iran Newspaper) (See **Figure 3** & **Figure 4**).

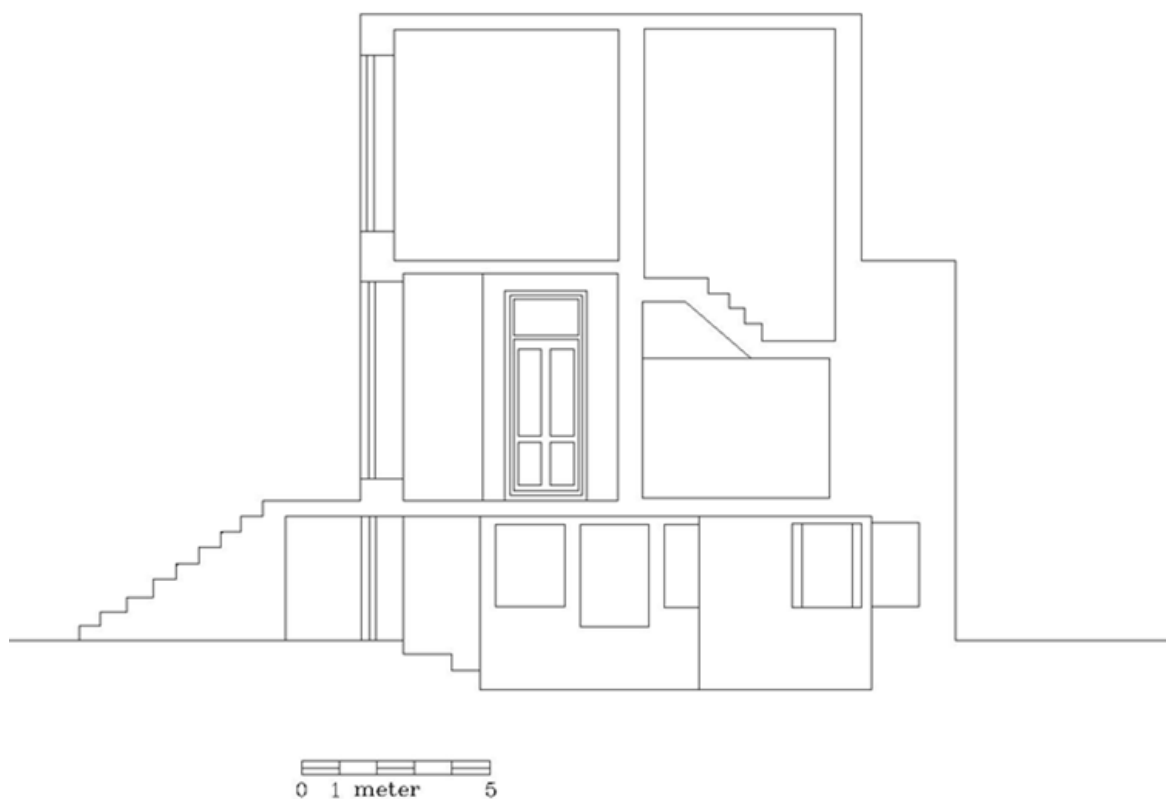


Figure 3. Section of Parvin Etesami House (Developed by the Author).

Parvin Etesami House opened as a place for women of East Azerbaijan Province to be active in various fields. Eshrat Shayegh, a representative of the people of Tabriz in the Islamic Consultative Assembly, told Iran Book News Agency (IBNA): “Simultaneously with the opening of Parvin Etesami House, women of the province who are active in various cultural, artistic, sports, social, research, and commercial fields will be appreciated during a ceremony.” She announced that she has been in correspondence with the Ministry of Science, Research, and Technology to include Parvin Etesami's poems in literature books, saying that: “Parvin's poetry is heavy but flowing, and although the form and format of Parvin's poetry are from yesterday, her views and thoughts are for today. We have also been in correspondence with the Minister of Education to include Parvin's poems and views in textbooks.” She added: “We have also reached agreements with the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan to prepare small books and brochures in several living languages of the world and give them to tourists so that they can become more familiar with Parvin and her poems.” She continued: “We have proposed establishing a research institute in the field of literature, and in this research institute, we will do a lot of work on understanding Parvin and her poems. We have also proposed that new neighbourhoods that are associated with culture and art be named after Parvin Etesami” (Archive of the Cultural and Tourism Heritage Organisation of East Azerbaijan, 2009).

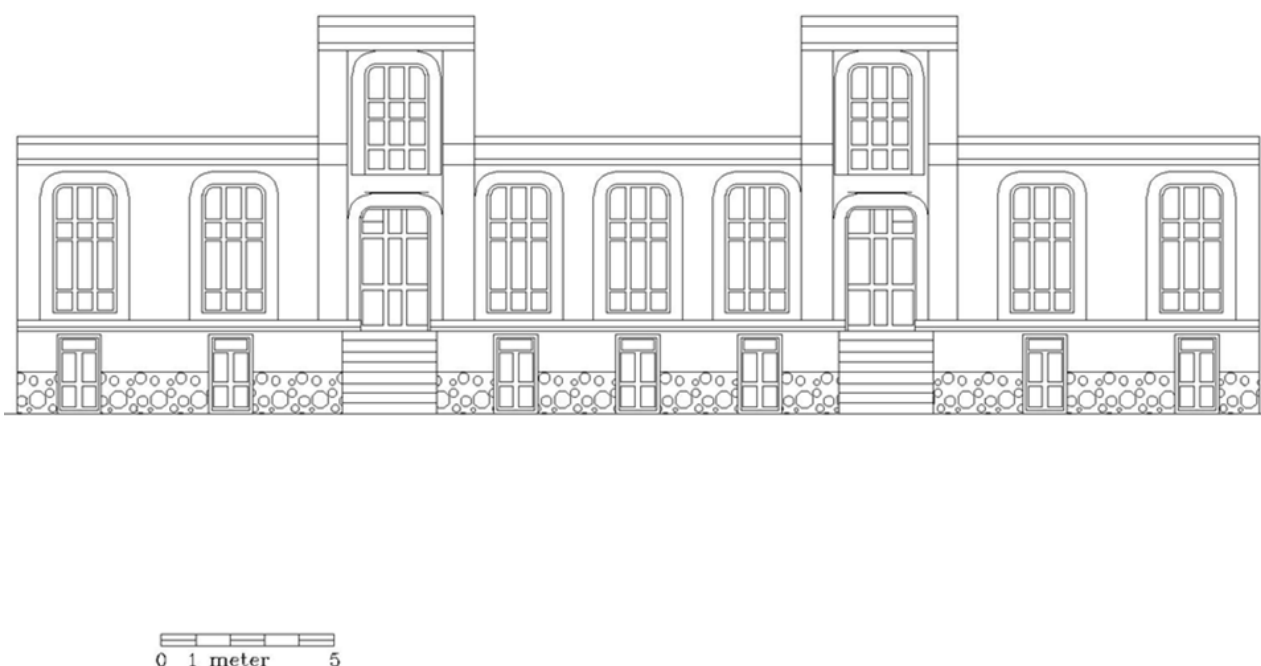


Figure 4. Elevation of Parvin Etesami House (Developed by the Author).

A year after the proposal to transform Parvin Etesami House into a research centre for investigation into her poems, the “Parvin Etesami Scientific Research and Cultural Foundation” was launched in the house of this contemporary poetess in Tabriz. The Director General of Women and Family Affairs of the East Azerbaijan Governorate announced the establishment of the “Parvin Etesami Scientific Research and Cultural Foundation” in Tabriz. Nasrin Pir-Semsari said at a specialised meeting on women's issues at the East Azerbaijan Governorate: “This foundation was established in the historical house of Parvin Etesami in Tabriz.” Referring to Parvin Etesami's birthday, she stated: “The Parvin Etesami Foundation was established to strengthen the foundation of the family, empower women in various areas of society, strengthen the faith foundations of families, and develop the cultural and literary activities of women in the province.” The Director General of Women and Family Affairs of the East Azerbaijan Governorate added: “The official activity of this foundation began at the beginning of 2010, and important works such as awarding the Parvin Etesami Special Year Award and holding meetings and specialised scientific workshops in various aspects of women's affairs, including culture, science, society, and religion, carried out in it” (Archive of the Cultural and Tourism Heritage Organisation of East Azerbaijan, 2009).

The Parvin Etesami Scientific, Cultural, and Research Foundation was launched in Tabriz in May 2009. Nasrin Pirsemsari, Director General of Family and Women Affairs of the East Azerbaijan Governorate announced this news in an interview with Fars, adding: “In line with the establishment of this foundation, the Parvin Etesami National Congress held in Tabriz in cooperation with the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan and the General Directorate of Culture and Islamic Guidance of East Azerbaijan in May this year.” She said, “Considering the purchase of Parvin Etesami's house during the President's first visit to the province, this house is being restored and renovated.” Pirsemsari added: “We hope that this house is available to the Parvin Etesami Scientific, Cultural, and Research Foundation within the next four months.” Referring to some of the functions of this foundation, the Director General of Family and Women Affairs of the East Azerbaijan Governorate said: “This place becomes a gathering place for writers and researchers.”

He added: “Identifying some people with information about the life of Parvin Etesami and literary activists and editors of the poetry of this famous poetess of our country is another goal of establishing this foundation.” Pirsemsari, stating that Parvin Etesami also worked as the head of the library of the Martyr Bamonar Teacher Training Centre for a while, added: “We are trying to collect, record, and classify information from some of the deceased's colleagues and family.” He expressed hope that by establishing the Parvin Etesami Scientific, Cultural, and Research Foundation, a series of research activities can be produced and collected in honour of Parvin Etesami, who used to write poems on the topic of resurrection and hijab during the repression period. The Director General of Family and Women Affairs of the East Azerbaijan Province also announced the publication of the *Reyhaneh al-Nabi* magazine by the General Directorate of Family and Women Affairs of the East Azerbaijan Province and added: “The website www.reihanenabi.com has also started its activities as the base of this general directorate” (Iran Zamin East Azerbaijan Newspaper, Wednesday, April 16, 2009, Year 9, Issue 2465, p. 1).

Important Events and Description of Operations

- Cleaning the thatch on the east room (11) wall due to moisture damage.
- Replacing the wall of the eastern room due to the wear and tear of the bricks over time.
- Axe-cutting of whitewashed stones for use in ponds, stair treads, and plinth stones on façades.
- Construction of stairs from the eastern side of the yard to the basement (7) for easy access from the yard to the basement.
- Reducing the height of the existing basement stairs to the kitchen using stone and mortar (4 and 13).
- Removing the wood above the windowsills and converting the upper part of the windowsills into an arch due to rotting wood.
- Implementing a Roman arch in the basement in front of the skylight (5).
- Replacing the wall of the western room due to the wear and tear of the bricks over time (19).
- False ceiling implementation (10, 11, 12, 17, 18, 19, 20): Using purlins (purlin is a piece of wood approximately half a meter long and 10 centimetres thick that is used to indirectly connect the rafters to the main beam) to indirectly connect the rafters to the beam with nails.
- Space Hall (15) installing Rabbitz for the implementation of a false ceiling.
- Applying plaster and soil to space (6) for whitewashing the infrastructure.
- Performing space-filling (15) to level the wooden beams for ease of connection to the rafters.
- Applying plaster and soil to space (5) for whitewashing the infrastructure.
- Space ceiling rabbeting (4) for plaster and soil.
- Replacing or deleting the main entry point.
- Implementing a space arch (2), converting simple doorways into arched ones.
- Implementation of plaster and soil in areas (7 and 8) for whitewashing infrastructure.
- Removing the layer of mud from the roof of the vaulted ceiling (4) for making rabbets.
- Implementing a space arch (7), converting simple doorways into arched ones.
- Installation of space windows (11).
- Implementation of roof covering of space (15) and gutters to repel precipitation from the sloping part of the roof.
- Strengthening the corners of the walls at the junction.
- Converting the simple niches in spaces (13 and 14) into arched ones.
- Excavation for the foundation of the courtyard wall due to the replacement of the external walls.
- Plastering space (4) for whitewashing foundation.
- Making the entrance to the cellar an arch made of stone to repel moisture.
- Space-saving rabbeting (2) for plastering foundation.
- Plastering space (3) for whitewashing foundation.
- Plastering of space (15, 18, 19, 20) for whitewashing the foundation.
- Implementing a stone façade on the perimeter wall due to replacing the exterior walls.
- Plastering the attic space for whitewashing.
- Cementing the floor of spaces (9, 10, 12, 18) to level the final floor.
- Preparing plaster moulds for the arches of the eastern façade body to execute the arches.
- Cementing basement window floors to create a foundation for window floor spray-proof stones.
- Execution of the arches of the eastern façade (See **Table 1**).

Table 1: Pictures of Before and After the Process of Restoration of Parvin Etesami House (Developed by the Author).

Before/During Restoration	After Restoration
	

The main entrance of Parvin Etesami House is from the alley.



The other door of Parvin Etesami House from the alley view.



Main façade of Parvin Etesami House from the yard view.



A fireplace that is repaired in underground space number 4 of Parvin Etesami House.



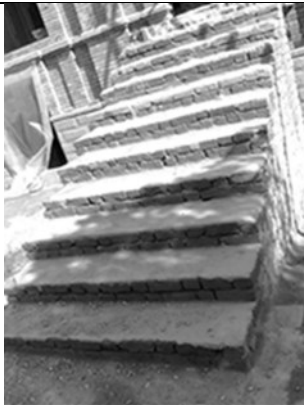
Wall niches changed from a square shape to an arch form in spaces 9 and 10 of Parvin Etesami House.



Using stone to reduce the height of the first step in the basement of Parvin Etesami House.



Construction of an arch in the basement of Parvin Etesami House.



Stairs made of bricks and stone for entering Parvin Etesami House in front of spaces 12 and 17.

Problems in the Restoration Process

- Damaging the building by replacing the existing wall with another wall without any documentation.
- Lack of proper protection of the building's main doors and windows.
- Lack of proper protection of the main columns and column heads of the building.
- Workers are not wearing safety helmets.
- Lack of a designated break room for workers.
- Workers hammer nails into the wall of a historic building to hang work clothes.
- Breaking the building's main gutters and using them as piles in the basement.
- Removing niches without a valid reason - Installing an arch in a basement skylight.
- Installing plastic pipes instead of the building's original gutters.
- Absence of night stay of the guard.
- Resizing windows without precise documentation.

- Implementing a stone facade without historical documents.
- Executing a façade arch without sufficient documents.

Troubleshooting Suggestions

- Accurate and proper documentation.
- Proper storage of doors and windows, and a suitable warehouse for columns.
- Safety is the first condition of every workshop (workers must wear safety helmets).
- Considering a special space for workers.
- Informing people and workers about the values of cultural heritage, so as not to harm historic buildings.
- Suitable storage for gutters.
- Respecting the authenticity of the historical building.
- Ensuring the security of the workshop.

Discussion and Conclusion

Parvin Etesami House was restored by the Cultural Heritage, Handicrafts and Tourism Organisation of East Azerbaijan and reused as a cultural centre in Tabriz. The plan of the building is changed in the basement and the first floor plan, and in the yard, the walls are renovated and arches are added to the interior and exterior sides of the building. The square and rectangular niches in the walls are changed in the form of arcades, and arches are added to the entrance of all parts of the building on both floors. A new passage is added to the basement between two spaces which used to be separate from each other, and an arcade connects the two spaces now. The windows from the main hall of the building on the first floor have access to the kitchen in the back, are glazed, and the plan of the building has been changed completely without documentation. Lack of respect for authenticity and lack of documentation of main changes and irreversible alterations are the biggest problems with the adaptive reuse of this historic building.

One of the most important differences between the Qajar and Pahlavi era buildings is that the arches and arcades of Qajar period buildings changed into simple square and rectangular niches and entrances in the Pahlavi era. As Parvin Etesami House was built during the Pahlavi era and the restoration process, the new arches and arcades are causing misconceptions about the original date of this building to be considered as a Qajar era house. Using cement in the yard and irreversible materials and huge changes is not considered appropriate for the adaptive reuse of cultural heritage, which indicates disrespect to the authenticity of this historic building. Although this project has so many imperfections and needs improvements, the restoration of precious historic buildings is better than neglect and abandonment of cultural heritage. There are so many abandoned and neglected historic buildings in Tabriz (more than 800 historic houses) which need conservation and restoration immediately.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The author takes all the pictures and draws, edits, and extracts all the figures of the maps from the AutoCAD programme. The author translates all the English text from the Persian Language. This research is the result of the project about the restoration process of Parvin Etesami House in Tabriz, Iran, by the author under the supervision of Associate Professor Dr. Reza Abouei during Master's studies of the author at the Art University of Isfahan in the Spring Semester of 2009. This article was accepted for online presentation at the 8th International Conference of Contemporary Affairs in Architecture and Urbanism held by the Architecture Department of Alanya University, Alanya, Antalya, Türkiye, and presented at the aforementioned conference from 8-9 May 2025 (Babazadeh-Asbagh, 2025, May 2).

Conflict of Interests

The author declares no conflict of interest.

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Chapter 14

The Importance of Roman Temples in Urban Morphology through the Augustus Temple in Nicomedia

* Melike Kavşut, Elif Yeşim Kösten

Introduction

Anatolian geography, which has hosted many civilisations, has a multi-layered and multi-identity structure in cultural terms. In Anatolia, which is located at the intersection of the migration routes between east and west, great civilisations between 2000-600 BC have created unique urban spaces. Each civilisation was influenced by the cultural identity of the geography they migrated to, and especially the phenomenon of religion played an important role in the shaping of cities. Sacred places and temples became a point of attraction for each new civilisation, and although new layers were added, they preserved their place in the memory of the city. During the reign of Augustus, who started the Roman Imperial period and ruled the empire between 27 BC and 14 AD, the whole Anatolian peninsula came under the sovereignty of Rome. The Roman religion, which had a polytheistic religion understanding until this period, deified the emperors with Augustus and it was a new period in which temples were started to be built. In addition, with this period, the emperor attributed the honour of having a temple dedicated to the imperial cult with the title of neokoros to certain cities and gaining a special status. During the Tetrarchy period, which began with the accession of Diocletian in 284 AD, the centre of gravity of the Empire shifted from the traditional capital Rome to Anatolia and Nicomedia became the eastern capital of Rome in 286 AD. During the emperor cult that started with Emperor Augustus, Nicomedia was given the title of neokoros three times.

The biggest factor that interrupted the cultural continuity of the city of Nikomedia was earthquakes. The city, which was the capital of the Eastern Roman Empire and was destroyed many times, was repeatedly repaired and crowned with stronger public buildings due to its strategic importance. Although it lost its former importance with the transfer of the capital to Constantinople in 395 AD, the city's transport axis and public buildings continued to exist.

Another factor that influenced the transformation of the city as much as the earthquakes was the impact of the urban pattern reflecting the cultural life of the Roman Empire on the Ottoman Empire. Written sources show that while the road networks and public foci that form the morphological structure of the city were preserved, especially the religious and administrative building typologies were structured according to the new order. Opened on 3 May 1873, the Haydarpaşa-İzmit Railway was the first railway built with state funds in the Ottoman lands and transformed the sea city of Nicomedia into the railway city of İzmit. The urban fabric, which continued to be transformed with the urbanisation policies and modern planning decisions of the Republican period, made the biggest break with the filling areas that interrupted the city-coastal relationship interrupted by the D-100 highway and railway transportation axes positioned parallel to the coast after 1960.

While it was not subject to construction due to the limited urban development until the 1970s, the applications of filling areas to be dried for the purpose of combating epidemics, flood control or land acquisition were formalised with the İzmit zoning plan approved and put into practice in 1973. İzmit, which is no longer fed from the coast, has lost its identity as a capital city and turned into an industry serving Istanbul / Constantinople, has turned into a structure in which the traces of cultural heritage are increasingly faded with the holistic planning decisions that continue to be taken afterwards, where cultural heritage is not protected.

The importance of this study lies in the lack of studies that can reveal the cultural identity of the city of Nicomedia, which was such a religious and political centre, the capital of the period and home to many architectural structures. In this context, by overlapping the urban fiction of the Roman Anatolian geography with the urban morphology of Nicomedia, the traces of written literature, travelogues and individual determinations of important public buildings that constitute the

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How to Cite This Chapter:

Kavşut, M., & Kösten, E. Y. (2025). The importance of Roman temples in urban morphology through the Augustus Temple in Nicomedia. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 166–182). Cinius Yayınları. <https://doi.org/10.38027/N14ICCAUA2025TR0032>

historical memory will be traced, and thanks to the multidisciplinary reading method enabled by urban morphology, a city reading will be made through the temple architectures, which are the most important focal structures of the city.

Greek and Roman Temples in Anatolia

Since the first day of human existence, man has created his own sacred. Ancient civilisations had belief systems based on the life-giving forces of nature. Each force of nature was symbolised as a god and tried to make life and natural events meaningful. The earth, which gives fertility, was symbolised with a female character and was called by different names in various civilisations. As the agricultural society developed and transformed from city states to kingdoms, the characteristics of the gods in the belief systems changed. The mother goddess evolved into a goddess representing the fertility that comes with agriculture, or transferred her fertility-related characteristics to gods and goddesses with other names.

Anatolian geography has been home to civilisations since antiquity and has enabled the temples and beliefs of thousands of gods to survive to the present day. The difficult passage of large and high mountain ranges in Anatolia, climatic differences and difficulties did not allow a single state to take the whole of Anatolia under its sovereignty. The Hittites ruled only in Central Anatolia, the Phrygians in a part of Central Anatolia, the Urartians, Lydians, Lycians, Lycians and many other tribes ruled only in a small region of Anatolia, and the Greeks generally established small city states on the coasts (Akurgal, 1993). As the Hittite Empire, one of the oldest and largest civilisations of this geography, expanded its borders, it established a multi-cultural and multi-faith lifestyle by incorporating the gods of each culture it conquered into its own gods. This civilisation, which developed culturally, politically and religiously as a result of this choice, was destroyed by the second Aegean migrations in the XIIth century BC and these tribes continued on their way towards Syria after burning and destroying the cities established before them (Aktüre, 1997). However, some of these tribes settled in Western Anatolia and formed the Greek States (1000-700 BC). The political and sacred areas that formed the formal essence of the state became a nucleus and this organisation was called 'city-state'. As a result of market relations and strong relations established over the sea, they chose coastal slopes with natural protection opportunities as settlements.

When we look at the morphological formation of the Greek state cities that developed and spread in the classical period, we encounter an urban typology consisting of the 'Acropolis', which means 'high city' in Modern Greek, built on a high place, and the houses on its outskirts, including the agora. In Classical Greece, every important settlement had an acropolis and acropolises were the most important areas of large cities. The acropolis also had a religious function and included temples, treasuries and various institutions. The acropolis, which was reserved only for temples in the 5th century BC, was used as a shelter for the city people during an attack due to its location on a hill. Ancient Greek Civilisation built many Acropolis in Anatolia as well as in Greece.

The period when the cities in Anatolia started to be designed in a planned manner is the Hellenistic period. While the Persian invasion and the destruction of cities were observed in 500-400 BC, the Hellenistic period was experienced in Anatolia between 330 BC and 30 BC. One of the most important features of this period is the development of urbanism. In the reconstructed or newly founded cities, porticoes increased in the streets intersecting at right angles, winged stoas were built, agora plans were organised, and municipal council buildings were constructed. For Hellenic cities, the temples dedicated to certain gods or the temple of the greatest god of that city hold the centre, and the city structure is completed with the bouleuterion (city council), baths, theatre, odeon and the agora, which is the largest square where the roads intersect.

Archaic and Classical Greek religion, unlike the polytheistic beliefs that preceded it, is rooted in its own culture as well as in other traditions intertwined with Hellenic civilisation. It had no prophet or messiah to spread the religion, no dogmatic character, no specialised clergy, no church, and no text-based holy book. Despite all this, temples, sanctuaries and other religious buildings in Greek cities have an important place in the daily life and culture of the people. The temples are mainly located in the Agora and forum areas and in the Acropolis region. While the temples located in the Agora area reach more people by being located in the centre of the city, the temples located on the Acropolis have become a sign element by emphasising the protective nature of the gods. Temenos, which is defined as sacred lands surrounded by private walls within the city, points to the fact that the Greek terms temple and cutting are interpreted together and accordingly, the creation of a clearing by cutting trees in the forest, opening an empty space, separating this area from the natural and wild and sanctifying it.

In the temples in the temenos, the gods reside there permanently with large cult statues in human form. This space, which is seen as the home of the gods, is public and the common property of all citizens. the most important design element of these typologies is the surrounding walls. Within these boundaries there is inviolability and only the rules of the god are valid. There are also water reservoirs for the purification ritual before the cult. The reason for the proximity of these 'temenos' areas to the agora and the city centre was determined by the desire of the lower class people to come together without feeling the pressure of influential people.

Philosophers, who thought about how the ideal city should be, also expressed their thoughts on the location of the temples. In this context, in Plato's Laws, he states that the temples should form a circle surrounding the city and the agora in the centre, and that this returns to the city as a circle of purity, cleanliness and security, adding both a

material and spiritual protective feature to the city. Homer, on the other hand, defines the reason for this as the transformation of the *Temenos*, which were defined as sacred areas, from the areas where the fertile lands reserved for the lords of the city were bounded, to the land belonging to a god, which was rented out and with this income, both the needs and the cult requirements of the temple were fulfilled.

The personalities of the gods and the wisdom assigned to them also determine their locations in the city. For example, there are statues of Hermes, one of the most popular gods of Greece, in public squares and areas where trade is most intense. As the cunning god of travellers, thieves, sellers and merchants, he waits for the city dwellers in the squares of the Agora and on the roads where merchants travel with their goods. These statues were believed to protect traders and travellers against thieves. In the agora, one of the most important urban spaces of the polis, Hermes' title is *Agoraios*, and the female version of this epiclesis was used for Artemis, Athena and Aphrodite as *Agoraia*.

It is believed that the gods have prophecies and their spatial organisation with the place they choose is shaped accordingly. In the time of Pausanias, in order to consult Hermes, who was believed to be looking at a hearth surrounded by oil lamps in the market square in Phares in a prophecy, they would enter the agora at dusk, burn incense and oil lamps in the hearth, and then place a coin and an inscription on the altar. After these rituals, the petitioner would whisper a question in the god's ear and cover his own ears to block out all other outside noises. They would go out of the agora with their ears closed and accept the first sentences they heard as prophecy. Because of this divination practice, the ritual spaces were designed to be isolated from the outside world.

Considering the regions of Western Anatolia, Greece and Italy, which were heavily influenced by Hellenic culture, it enriched the urban planning and the planning of sacred areas designed with temples that shaped the city. While the streets in the cities of Greece were very narrow and the buildings were in the form of a dense texture, the cities in the Hellenised colonies were built according to a pre-designed plan. The direction of the city was determined by calculating the wind and sun, and wide and smooth streets intersected at right angles to regulate traffic (Mutlu, 2001). In this period, new cities were established in important and suitable areas that were not inhabited by people. In most of the Hellenic cities built by the sea, there are king residences spread over a large area, consisting of palaces and parks. These residences were located at the back of the hill and in the best-protected part of the hill, while the library, theatre and armoury were also located in this part, and several temples, court buildings and gymnasium were located on the main street running on the east-west axis. While all Hellenic cities were built according to similar regular plans, all large cities of this period were built similarly enough to be compared with each other. The cities in Western Anatolia were built either on a small peninsula, on the seashore or a little inland from the coast close to the sea (Akurgal, 1993). Akurgal (1993) stated that the reason why most of the Aeolian and Ionian cities in Anatolia were built on small peninsulas or on the seashore was that the Hellenes were sailors and lived on a market economy based on trade and exchange. In the morphological shaping of the cities, sanctuaries dedicated to the gods of the Ancient Age appeared in the Hellenic world and special attention was paid to the location of the sanctuaries in urban planning.

The sanctuaries are generally positioned in visual relationship with the theatre and agora structures. One of the best examples of this typology is Priene Athena Sanctuary. The perspective view of the sanctuary from the agora and the theatre was made as a design input and it was positioned in such a way as to give a perspective view with a viewing angle of 18° from the agora and the theatre. The Athena Sanctuary in the ancient city of Miletus, located in the Ionia region, is located adjacent to the southwest wall of the West Agora of the city. The sanctuary is orientated in the northeast-southwest direction and its facade faces southwest.

Sacred Space in Roman City Fiction

During the years 30 BC - 395 AD, Anatolia was one of the geographies with the most developed lands in the world. Since the Western Anatolian cities of this period came under the influence of the Roman Empire starting from about 200 BC, they had a level that did not lag behind Rome in any way. Roman architecture is a statist, practical and general-interest architecture (Ünsal, 1973), and it has preserved and developed this influence, especially in all geographies that have the heritage of Hellenistic architecture (Mutlu, 2001). The economy of the Romans was highly developed and accordingly, they utilised this economy in culture, art and primarily in public architecture, as well as agriculture, trade, basic industrial production, weaving and shipbuilding. Trade was mostly on a local scale and maritime transport was at the forefront. They created regional urban networks, parcelled agricultural areas, established new cities or developed old cities and gave importance to the construction of roads.

In Roman cities, the centre was monumentalised at a level where the power of urban planning and architecture was endowed with art, science and technique, and residences were pushed out of the centre in terms of hierarchy (Kolb, 1996). Roman cities, like most Hellenic cities, were geometrically planned; they were divided by diagonal roads, consisted of regular and quadrangular islands, and in the city plan, the two main streets in the north-south and east-west directions met and intersected in a square in the middle; in fact, the Romans inherited these principles from the Etruscans, and the principles of urban planning were also found in Greek, Egyptian and Chinese cities (Ünsal, 1973). Between the years 0-200 A.D., Roman Emperors built gymnasiums, stadions, theatres, municipal and

agora buildings, baths, libraries, comfortable houses, shaded colonnaded roads and large squares in every city with the taxes collected from the citizens (Akurgal, 1993).

Unlike in Hellenic cities, the centre of religion in Rome was the *domus* (house). In every house there are sacred sections where offerings are made and there is also a Greek-like pantheon of gods. For example, the equivalent of Zeus in the Greek pantheon is Jupiter in the Roman pantheon. Jupiter is also considered the protector of the state. The construction of the first real temples in Rome was inspired by Etruscan examples. The Etruscans were a very powerful civilisation living in the Etruria Region, today known as Toscana. The Etruscans became a very powerful civilisation here. Thanks to this power, they created a sovereignty area including Rome. Etruscans spread from the north of Rome to the north of Italy. However, traces of this culture extend even further north, to the Po River valley and the southern parts of Italy. The Etruscans, especially through trade, had a long cultural interaction with the Greeks, who began to colonise Italy in the early 8th century BC, and indirectly with the peoples of the Near East. Within this interaction, Greek influences on Etruscan religion and Etruscan gods began to manifest themselves from the early periods. Roman art and architecture could never be as original as Greek and Etruscan culture. Roman temples were greatly influenced by Etruscan temples. In the 6th century BC, Rome interacted with the Hellenes and thus the elements of Hellenic temple architecture began to be seen in Roman temples. From the 2nd half of the 3rd century BC, Rome developed a unique temple architecture. This ideal plan type does not exist in either Etruscan or Hellenic architecture. Rome created an ideal temple architecture by blending these two cultures and adding its own unique features.

Roman architecture has a cosmopolitan and universal structure thanks to the vastness of its territory and the cultural richness obtained from these lands. With the 7th century BC, Rome's understanding of art changed. Local elements were combined with overseas relations and thus a cosmopolitan culture emerged. However, the advances in the construction techniques of Roman architecture were its main distinguishing features. Greek architecture is the product of a self-confident civilisation that succeeded in creating a complete fusion of artistic design during the creative period between the 7th and 4th centuries BC. When one encounters architecture made by or under the influence of ancient Greece, there is no problem in recognising that it is Greek and distinguishing its characteristics. This original development was nourished and increased by commercial and political relations. Especially as relations with Egypt and the Near East increased, interaction in art and architecture increased, which was directly reflected in the works. From the moment the Roman Empire was divided and the Christian Byzantine Empire became effective, the cities were transformed typologically. Especially pagan Roman temples located at key points in the urban morphology were converted into Christian Roman churches or monasteries. Today, very few of these temples have survived with their old plan typologies. However, these monumental structures, the traces of which we can easily see in abandoned ancient cities, have been used in the urban planning of temples and urban morphology. However, these monumental structures, the traces of which we can easily see in abandoned ancient cities, show how important the connection between temple and urban morphology is in urban planning (Cerasi, 2001).

A Turning Point in Roman Religious Understanding: The Temples of Augustus

Ancient Rome was a city-state founded in the Italian Peninsula and grew around the Mediterranean and was under the rule of a single ruler. The Roman period started as a kingdom between 753-509 BC, as a republic between 509 BC and 27 BC, and as an empire in 27 BC when Emperor Augustus came to power. This period continued until 395, when, in order to ease the management with the growth of the territory, it was governed from two centres as East Rome-West Rome. In 476, Western Rome collapsed with the attacks of Germanic tribes coming to Europe with the Migration of Tribes, and Eastern Rome collapsed with the conquest of Istanbul by the Ottoman Empire in 1453.

The Roman Empire had a very diverse and eclectic belief system due to its vast territory and multicultural structure resulting from the fact that it was home to many civilisations. The religion, which initially adopted the practice of offering gifts to the spirits that governed nature, water, trees and the fire of the home hearth, centred on the house called "*domus*", and in this house, sacred sections were arranged where gifts and offerings were made to the spirits. Inspired by Etruscan and Hellenic architecture, it was developed and finalised with original interventions. The period of the Roman Empire, which began with Emperor Augustus in 27 BC, witnessed significant changes in the world of belief and worship. In addition to serving social needs, Roman religion was used in many areas from the development of the empire to its expansion.

The biggest innovation in the world of belief in this period was the deification of the emperors and the construction of their temples. Emperor Augustus was the initiator of this structuring. Augustus was an emperor who used mythology for ideological image and propaganda (Gradel, 2002: 34-35). He had a policy aiming to be the sole power by shaping his own image (Burgon, 2005: 23). By associating himself with Apollo, Augustus took the role of the representative of Apollo, the patron god who disliked immorality and excess (Albasan, I, 2020). The biggest step he took as a propaganda element was to order his temple to be built in the cities he determined and to grant privileges to these cities by giving them the title of '*neokoros*'. This system was continued by other emperors.

Neokoros is a Greek word meaning temple guardian. Temples of Augustus were built only when the city was given the title of neokoros. During the ancient Roman period, the honorary title was given to Greek cities, especially in Asia Minor (Anatolia), indicating that the city was home to a temple dedicated to the imperial cult. Some cities increased their prestige by receiving more than one neokoros title. Most of the cities with neokoros titles are located in Anatolia, i.e. within the borders of Turkey. These cities built temples dedicated to the emperor cult by following policies in line with Rome. The main reason for this is that Anatolia was one of the most economically and culturally rich and important regions of the eastern provinces of the Roman Empire. The number of known cities with the title of neokoros is 37 in the world and about 30 of them are located in Anatolia. In Western Anatolia, especially large cities such as Izmir (Smyra), Ephesus (Ephesus), Pergamon (Pergamon) and Izmit (Nikomedia) have received the title of neokoros more than once. These numbers and information are confirmed by inscriptions, ancient sources and especially coins.

Roman temples are a visual example of Roman religion. Besides being religious buildings, they also serve public use. The temples built do not have an architectural typology specific to the gods to whom they are dedicated. However, depending on the morphological structure of the city, the temples were shaped according to the area designated for the construction of the temple and the ability to afford the cost. There are temple forms named as Anta, Anta-Double, Tholos, Prostyle, Amphiprostyle, Peripteral, Dipteral and Pseudodipteral. The colonnade surrounding these temples is called peristatis. The extending end of the side wall of the temple is called Ante. The Naos is the sacred part and contains the most sacred part, called the adyton, where the cult statue is located. The Pteroma is the area between the Naos wall and the Peristatis colonnade. Finally, Opisthodomos is the name given to the section behind the Naos wall.

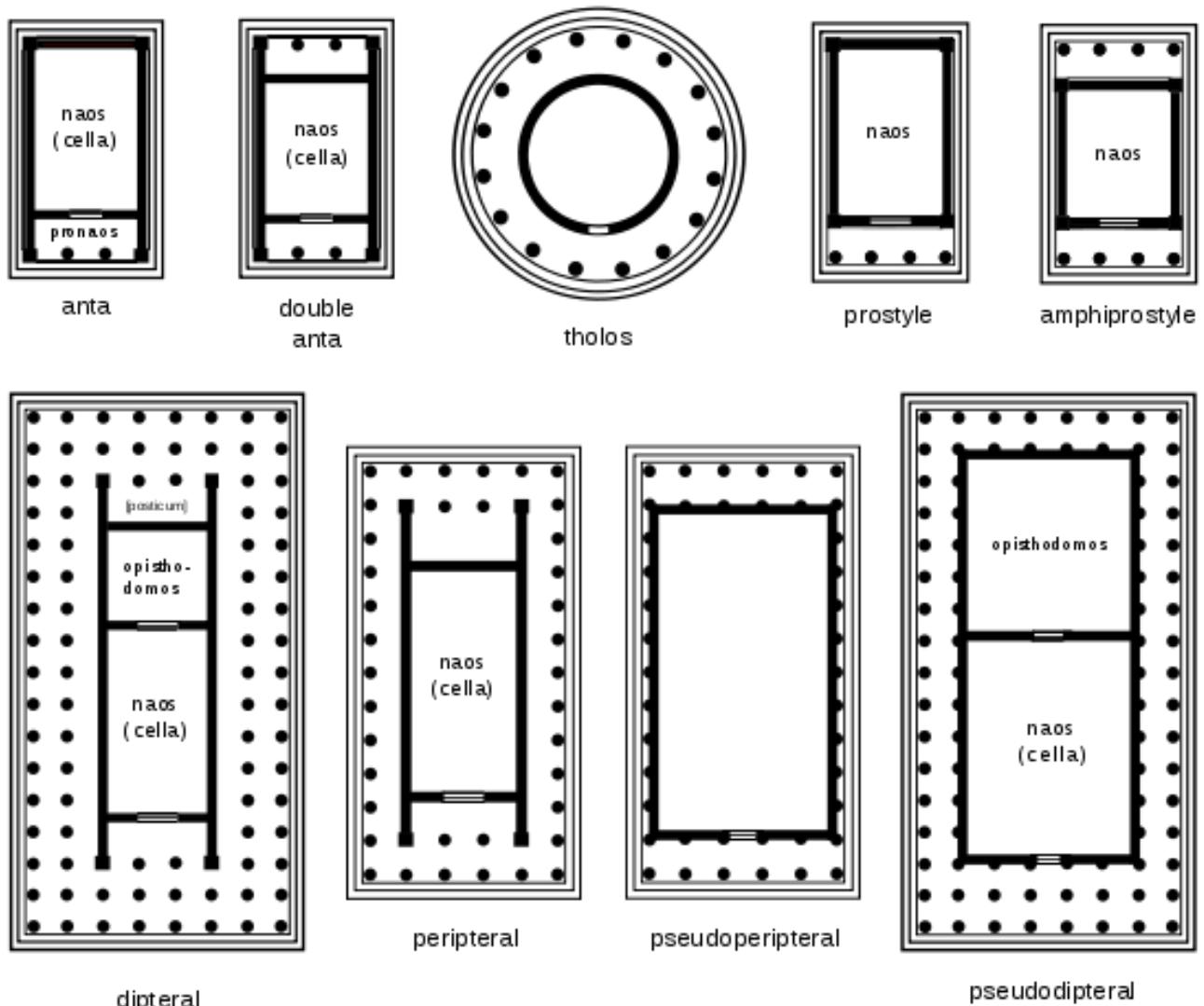


Figure 1. Temple Plans

The temples of the gods, who are seen as the supreme protectors of the city, are built on the hills dominating the city. The reason for this is the need to dominate the city at every point and to depict its greatness closest to the

sky. While determining the location of the temples, the area is chosen by taking into account the characteristics of the god to whom the temple is dedicated. For example, Mercury is an important Roman god in the field of profit and trade. For this reason, temples dedicated to Mercury were usually built in forums or trade centres. For the temples of Asclepius and Salus, who are believed to cure many patients with their healing powers, areas with water sources were determined. Apollo, the god of art, was located next to the theatre, Hercules, the symbol of power, was located in amphitheatres or sports fields, Mars, the god of war, was located outside the city but within the training area, and the temple of Venus, the goddess of love and beauty, was located at the main gate. Vitruvius mentions that the fortune-tellers had placed these temples outside the city so that Venus could protect the city from fire and disasters with prayers and Mars could form a shield against enemies. For the temples of other gods, areas were also selected according to their characteristics and built in the allocated spaces.

There is no specific direction when determining the direction of the temple facade. The entrance facade is mostly orientated to the west. The reason for this is that due to the presence of the altars positioned in front of it, when the people who come to sacrifice are directed towards the statue of the god, they are also directed towards the east direction where the sun rises. Thus, while praying, they both turn towards the temple and look at the east direction, which is considered sacred. However, if the place is not suitable for this, the facade of the temple is orientated in the direction of the city view as much as possible, or if there is a water source such as a river in the vicinity, it is also directed towards this view.

Another determinant of the typological characteristics of temple architecture is the monumentalisation by transforming the place chosen for the construction of the temple. After the location of the god to be depicted in the city is determined, it is excavated down to the hard ground and descended as much as the size of the structure requires. The entire ground is rubble and the ground is filled with coal. In places where hard ground cannot be found, piling is done. Then the foundation wall is made half a measure thicker than the height of the building and the column bases are positioned so that they do not protrude from the solid part of the infrastructure. The wall is raised and stabilised by pressing soil into the gaps and the columns are enabled to stand separately. After the foundations are brought to a certain height, the column bench is placed. The columns are arranged in such a way that the side facade is exactly twice as long as the front facade, so that the side facade is exactly twice the length of the front facade. The steps are designed to be an odd number. Thus, when you start climbing with the right foot, you will climb to the temple with the right foot (Vitruvius, 2017). All these structural and spatial typological features constitute clues that enable us to read the urban fiction in ancient cities through their contexts. The temples of Augustus, the majority of which are located in Anatolia, become very important in terms of the cultural heritage value of our country when they are evaluated both in terms of their place in the urban fiction and the neokoros title given, and the researches, excavations and excavations have an international importance.

Augustus Temples Found in Anatolia

27 BC The first emperor Caesar Divi Filius Augustus, who started the era of the Roman Empire, gave the most weight to public works in his lands after obtaining the title of Emperor, and supported this situation by placing part of the army in the colonies. He renewed the vitality of Roman traditions by making many arrangements in social and legal fields. In the wars that started in 17 BC and continued until 9 BC, the borders expanded and reached to the Elbe in the north of Czechia (Aydemir, 2022). In his own words, he "found Rome as a city of clay, but left it as a city of marble". During his period, Rome was a period of abundance and fertility never seen before in its history. In addition to these, the biggest innovation he made was that he was the first person to be deified in Roman history by developing a trend that enabled him to have a temple built by using Roman religion as a propaganda element. Augustus determined the cities where the emperor temple would be built and crowned them with the title of neokoros by granting privileges to these cities.

Temples dedicated to Augustus and buildings serving his cult were widely built in the cities of the Roman Empire in Anatolia. The largest part of the cities with the title of Neokoros are located within the borders of Turkey. These cities followed policies in line with Rome and built temples dedicated to the emperor's cult. The main reason for this is that Anatolia was one of the most economically and culturally important regions of the eastern provinces of the Roman Empire. The term neokoros was first given to Kyzikos in 38 BC and finally to Sardis in the 5th century AD (Baz, 1998, pp. 92-93). The number of known cities with the title of neokoros is 37 in the world and about 30 of them are located in Anatolia. Among these temples, the existence of Augustus Temples in Ankyra, Aizanoi, Sagalassos and Antioch has been proven with certainty. However, it is known through coins and ancient sources that there were temples or Sebasteion complexes dedicated to Augustus in major Roman cities such as Nikomedia, Psidia, Ephesus, Aphrodisias, Pergamon, Sardis and Side. In addition to those known for certain, there may be other possible temples of Augustus, supported by epigraphic or architectural remains. Definitive information on this subject should be clarified by archaeological excavations and epigraphic findings.

To give an example from the Augustus temples in Anatolia, one of the most important structures that we can trace typologically to the present day is the Ankara Augustus Temple. The Temple of Augustus was built in the city

of Ancyra in Galatia, in the Altındağ district of today's Ankara, between 25-20 BC. Galatia was an ancient region in the central Anatolian highlands, including Ankara and Eskisehir, named after the Gallic tribes who migrated from the Balkans to Anatolia and settled in the region. The Temple of Augustus in Ankara is one of the best preserved temples of Augustus. The Temple of Augustus has the only complete copy of the 'Res Gestae Divi Augusti', which describes the deeds of Emperor Augustus during his lifetime. It is written in two different languages, Latin and Greek. The Latin was inscribed on the ante-wall facing the pronaos (front room), while the Greek was inscribed on the outward facing side of the south-eastern wall of the cella (sacristy).



Figure 2. 1- Augustus Temple Sanctuary, 2-Antique Theatre, 3-Colonial Street, 4-Cardo Maximus, 5-Caracella Baths, 6-Roman Period Wall

Programmed as a sanctuary dedicated to the Phrygian god Cybele and Men during the Phrygian period, it was used as a sanctuary for the Emperor Augustus and the Goddess Roma during the Roman period. The temple is orientated southwest-northeast. It has a peripteros plan in Corinthian order, has an eight-step staircase and is placed on a podium. The temple is surrounded by 8 columns on the narrow sides and 15 columns on the long sides. In the plan order that has survived to the present day, there are 4 columns in front of the pronaos section, which is the front room, and two columns between two wall projections in the opisthodomos section, which is the back room.

During the Byzantine Empire Period, three large windows were opened on the southwest wall of the Cella, a closed space designed to prevent sunlight from entering the monument. At the northeast end of the Augustus temple, which was converted into a church, the wall between the opisthodomos, which also functioned as a treasure room in some cases, was removed and replaced with an apse wall and a crypt (Uçak, B., 2016). The position of the former opisthodomos wall is still evident in the inner parts of the side walls; on the contrary, the Byzantine apse wall can only be traced by the crypt walls between the former opisthodomos antechamber. This wall section and the crypt were not built using marble, the material of the original temple, but local stones. With the inclusion of the crypt, the length of the temple core was increased from about 28 to 37.5 metres. This cellar is entered from inside the temple through a small door. (Güven, S., 1998)

During the reign of the Ottoman Murad II in 1427-1428, the Hacı Bayram Mosque was built in connection with the northwest corner of the Temple of Augustus. This connection is physically in contact with each other. From the first written documents about the temple, the iwan added behind the opisthodomos and the graffiti written on the temple walls, it seems that the temple was used as a madrasah for a while after the construction of Hacı Bayram Mosque. The location of the Temple of Augustus, which has been stratified and subjected to interventions in the historical process, has made it one of the most important sacred areas of the city with the mosque and the tomb right next to it. In this change of function, no change was made in the temple structure, only the function was changed.

İsmet Fazıl Pasha Tomb, located in the courtyard of Hacı Bayram Mosque, is thought to have been built in the 18th century. İsmet Fazıl Pasha Tomb, which reflects the morphology of Ottoman tombs with its typological

approach, has an octagonal plan and is covered with a dome. With the mihrab inside, it was designed as a mausoleum and used as a muvakkithane after an unknown reason. Muvakkithane is a place where prayer times are determined and in some cases astrological studies are carried out (Şaşmaz, E., 2019). This situation leads to the conclusion that the functional transformation, which is a fate of the Temple of Augustus, is a palimpsest architectural typology not only in the temple, but also in itself, as a result of the fact that other buildings on the area where it is located.

Another temple, Kütahya Aizonai Augustus Temple is located in Çavdarhisar, Kütahya. It is one of the best preserved temples of the Roman Imperial Period. This temple is dedicated to Augustus and Zeus. It is one of the most important structures of the city of Aizonai. The city draws attention especially with the well-preserved Temple of Zeus, the theatre-stadium complex and the macellum, the world's first known stock exchange. Aizanoi was included in the UNESCO World Heritage Tentative List in 2012.

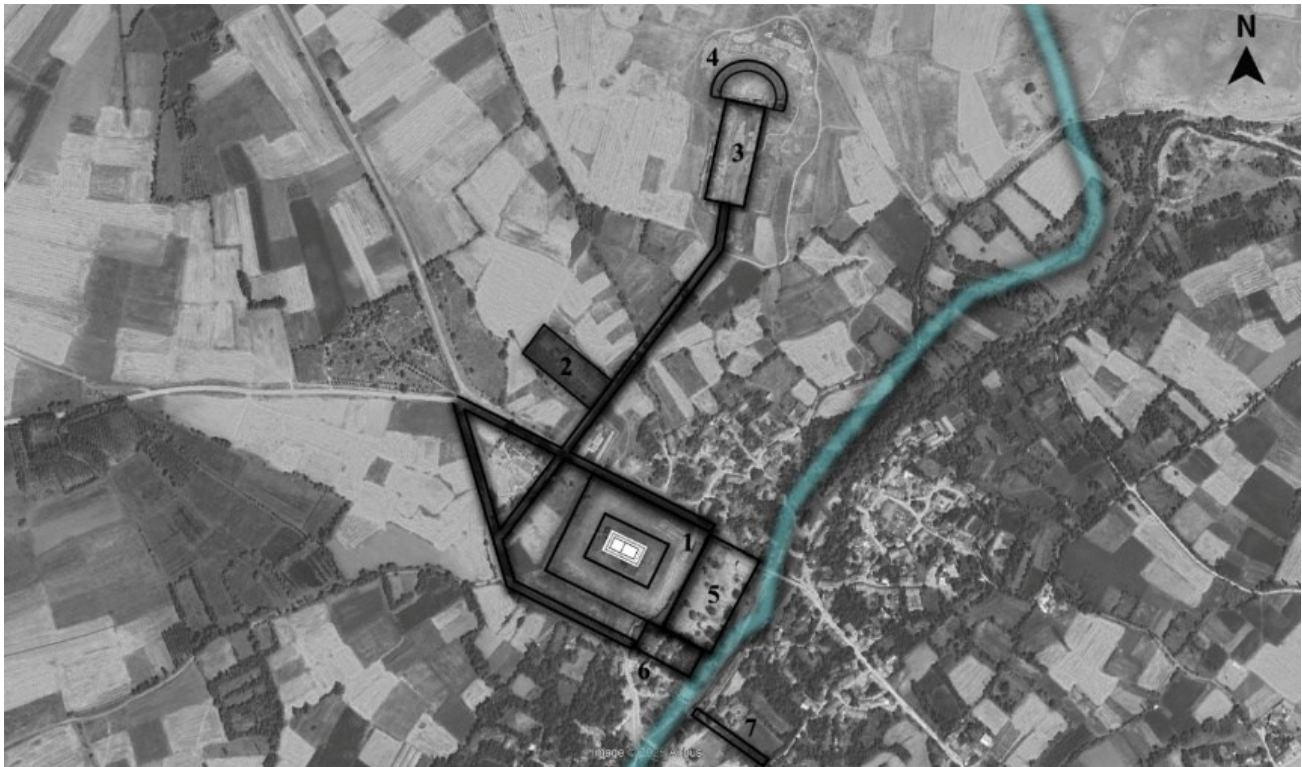


Figure 3. 1- Augustus Temple Sacred Area, 2- Roman Bath, 3-Stadium, 4-Antique Theatre, 5-Great Agora, 6-Doric Agora, 7-Columned Street

Although the Temple of Zeus, one of the most remarkable structures in Aizanoi, is dated to the Hadrianic period (117-138 AD) in terms of its architectural features and decoration style, some elements used in the construction of the temple may belong to the Augustan period. The inscribed architrave and other architectural details on the facade of the temple reflect the architectural features of the early period of the Roman Empire (Tandoğan, E. and Tandoğan, E. 2020)

The temple has a pseudodipteros plan, but in fact the inner row of columns on the sides has been removed. This architectural type is called pseudodipteros. The main sacred building (cella) is placed longitudinally and surrounded by columns. Its dimensions are approximately 35 x 53 metres. Local limestone and marble pavements with quality workmanship were used in its construction. The columns surrounding the temple are in Corinthian order with capitals decorated with acanthus leaves. There are 15 columns on the long side and 8 columns on the short side. The height of the columns is about 9 metres. The temple was built on a high podium. This feature was directly inspired by Roman architecture. At the bottom of the podium is a vaulted crypt. It is thought that this area was dedicated to the goddess Cybele. There are depictions of gods and mythological scenes on the friezes and pediment. There are inscriptions on the architraves; one of these inscriptions is dedicated to the emperor Hadrian. The temple has both religious and political meanings.

Sagalassos Augustus Temple is located in the ancient city of Sagalassos in the Ağlasun district of Burdur. Sagalassos is one of the strongest representatives of the imperial cult in Anatolia. One of the most concrete examples of this cult is the structure dedicated to Emperor Augustus and also known as the Temple of Apollo Klarios. The temple was built between 27 BC - 14 AD, during the reign of Augustus. Although the god Apollo is not a god associated with this city, it was built to honour the emperor Augustus as he was the god he considered closest to him. It is located on a dominant hill in the Lower Agora of the ancient city of Sagalassos. This strategic placement symbolises both religious and political superiority.

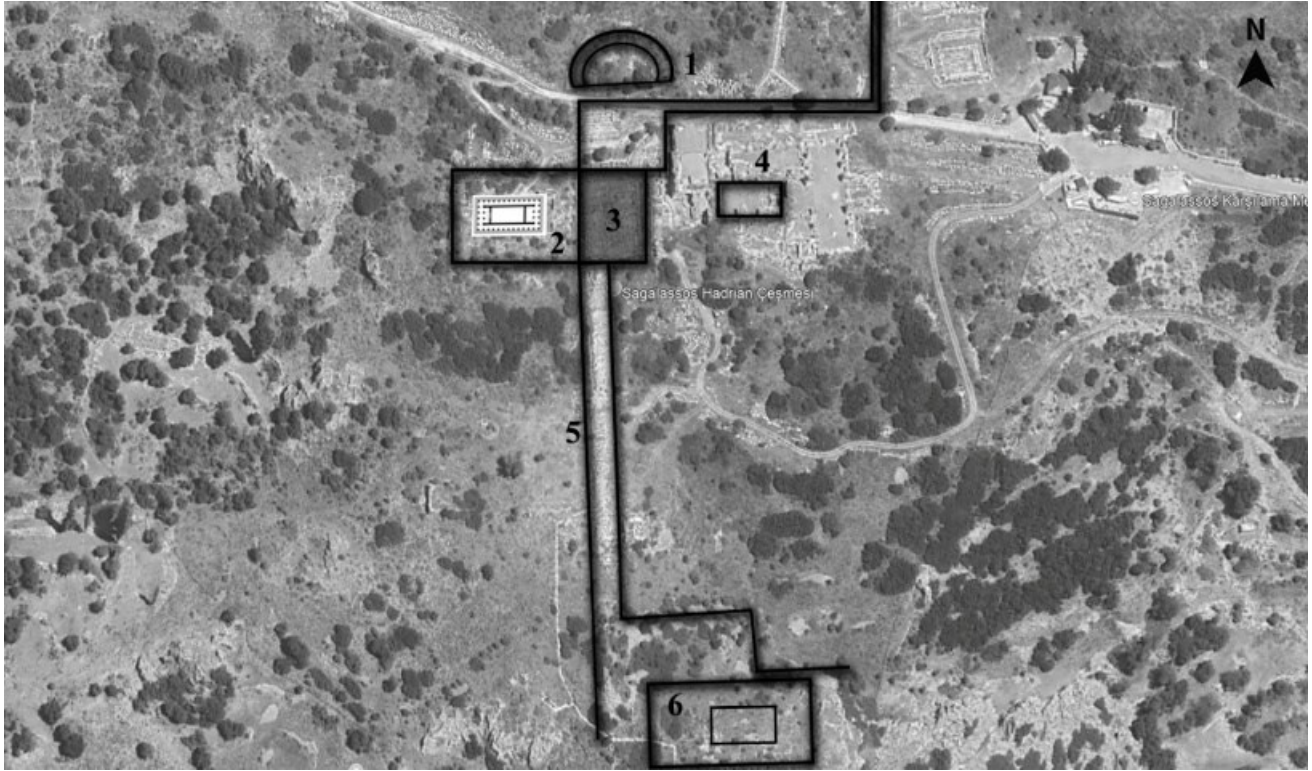


Figure 4. 1- Odeon, 2- Augustus Temple Sacred Area, 3-Lower Agora, 4-Roman Bath, 5-Colonial Street, 6- Antoninus Pius Temple Sacred Area

The temple is arranged as a sacred area with a temenos wall measuring 63 x 85 metres. It is thought that the statue of Augustus is located in front of this area. The temple was built in Ionic order. There are half columns on the front and rear facades. The temple has three main sections: pronaos (front entrance section), cella (main worship area) and opisthodomos (back room). These sections are designed with proportions reflecting the architectural understanding of the period. The temple, together with the other buildings of Sagalassos, shows the influence of Roman architecture in Anatolia. The inscription of the temple mentions the devotion to Apollo Klarios, Augustus and the abbot Titus Flavius Collega, his wife Flavia Longilla and her family (Sönmez, Z. 2020). This inscription appears to be a fragment of the *Res Gestae Divi Augusti*. It is accepted that the construction of the temple started in the Late Augustus Period and was completed in the Early Tiberius Period (Akgül Ö., S., 2013).

The Augustus Temple of Pisidia Antioch, located near the Yalvaç district of Isparta today, was reconstructed as an important colonial city during the reign of the Roman Emperor Augustus (27 BC-14 AD). In this process, the Temple of Augustus, which was built as a part of the imperial cult, is a concrete indicator of the influence of Rome in Anatolia. The temple was built on a rocky ground at the highest point of the city. This position symbolises both religious and political superiority. The architecture of the temple is in Corinthian order with four columns on the front facade. There are decorations such as wreaths and bull heads on the column bases. The pediment of the temple is decorated with lotus and palmette motifs, reflecting the influences of Roman architecture. The temple is surrounded by a two-storey semicircular portico, supported by about 150 columns. The platform is 14.2 x 27.95 m in dimensions and 2.6 m in height. The temple was built on this platform with dimensions of 13.6 x 23.5 m. While the sanctuary was used as a temple of Cybele and Men in the early period, it started to serve as the Temple of Augustus, and in the late period it was functionalised as an open-air church (Yalvaç Belediyesi, 2017).

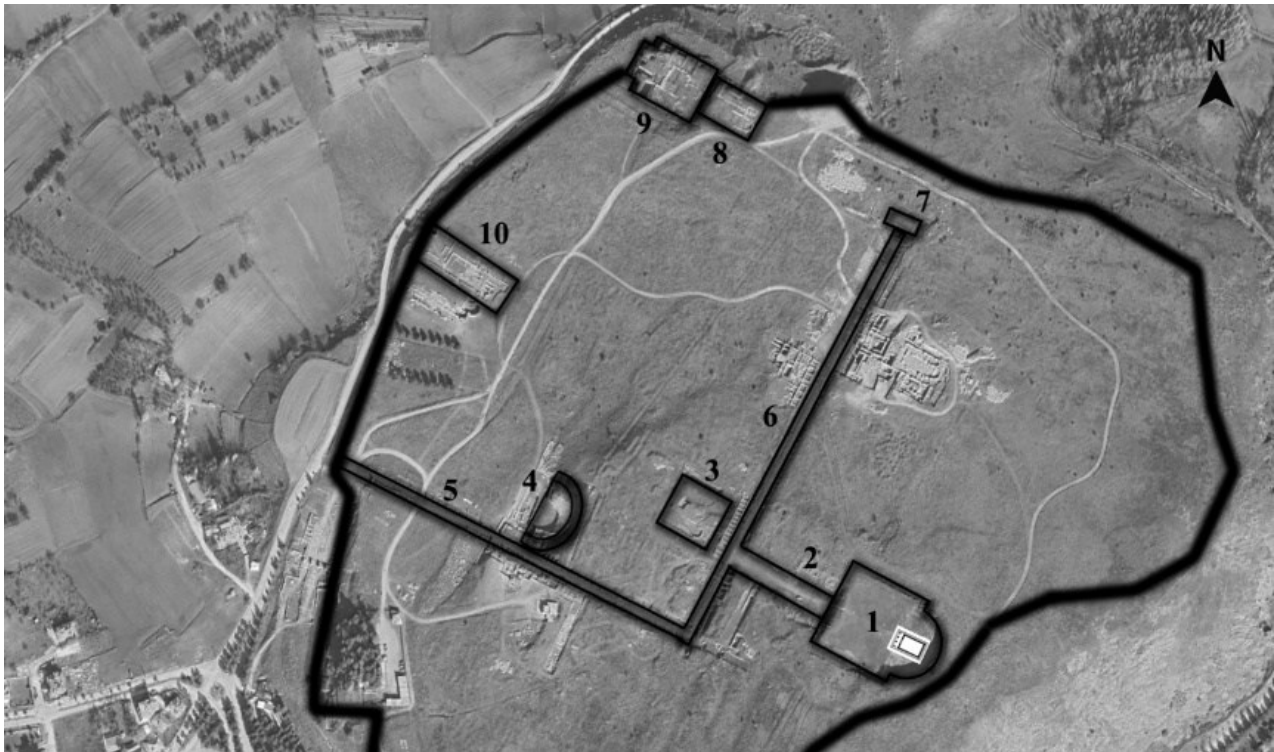


Figure 5. 1- Augustus Temple Sanctuary, 2-Columned Street, 3-Roman Bath, 4-Antique Theatre, 5,6-Main Street, 7- Nymphaeum (Monument), 8-Palaestra (Gym), 9-Roman Bath, 10-St. Paul's Church

When the table in which the geographical locations, dates, plan and column layouts, materials, podium features, dimensions, preservation status, facade orientation and artistic elements of the temples are tabulated, the similarities and differences with the typological data of the 4 Augustus temples sampled are tried to be revealed. Accordingly, in the next section, the urban fiction of the ancient capital of Nicomedia, which received the title of neocros many times, and the Augustus temple will be discussed in this fiction.

The Place of the Temple of Augustus in the Urban Morphology of the Roman Capital Nikomedia

The foundations of the settlement of Nikomedia, i.e. today's Izmit, were laid on Dua Tepe in 264 BC by Nicomedes I, King of Bithynia. The topography of the city is hilly and it was built on hilly areas providing natural defence (Strabo, *Geographica*, 12.4.2). In the Hellenistic Period, the city was founded as the Acropolis in 262 BC as the capital of the Kingdom of Bithynia, within the borders of today's Izmit district, on Dua Tepe between Kadıköy Neighbourhood and Bekirdere. Acropolis literally means the city located above. It is the name given to defensible hill settlements used for religious, military and political purposes in ancient Greek cities. This Acropolis has a Hellenistic and classical city fiction. Since the acropolis is at the top of the hill, living spaces were formed on the slopes and around it. The connection roads from these living areas to the acropolis wind around the acropolis instead of leading directly to the hill. The main reason for this is that it is a naturally developed route. The aim is to reach the hill by making the slopes on this road route as easy as possible. we can feel the traces of these roads to a great extent in today's city plan.



Figure 6. Location of Nicomedia in the Kingdom of Bithynia (Aktüel Archaeology Journal)

The city of Nicomedia, which was built on a hillside with the Hellenistic urban structure, evolved into a more regular grid plan after the Bithynian king Nicomedes IV gave it to the Roman sovereignty by will in 74 BC (Harris, 1980: 866). It developed as an important capital city during the Roman period. Due to its strategic location, port and administrative centre, it has been a geopolitically important coastal city and centre throughout history. It attracted the attention of many states thanks to its strategic location, its location on the trade routes between East and West and its convenience for maritime transportation, and it became a city rich in forums, baths, theatres and monumental buildings due to its administrative centre during the Roman period.

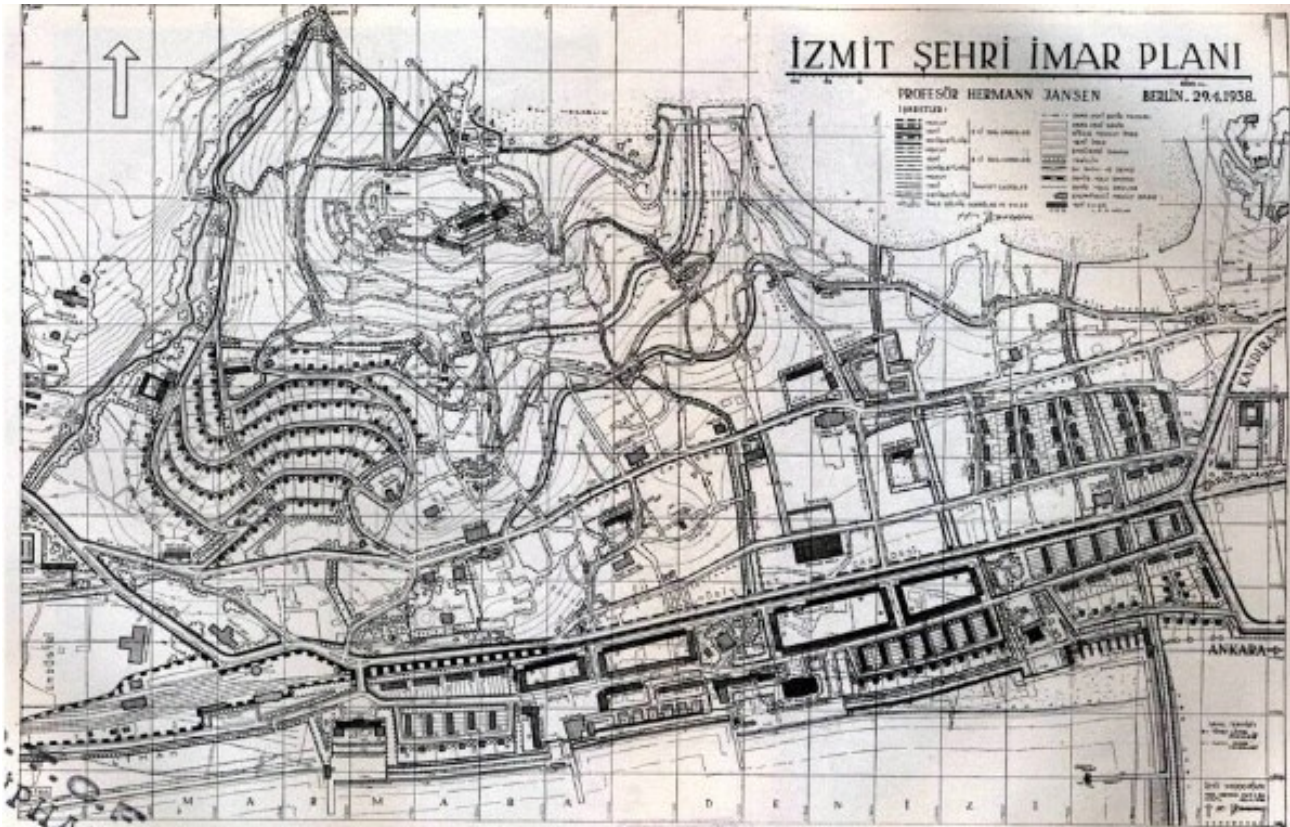


Figure 7. Traces of the Roman city grid plan in today's urban planning

The city was first established as a Hellenic city and then the Roman city structure was developed on the same fiction. With the Roman domination of Nicomedia, the city maintained its importance due to its geopolitical position and became one of the most important cities of the Roman Empire in Asia. In 284 AD, it was declared the eastern capital of the Roman Empire by Emperor Diocletian (Lactantius, *De Mortibus Persecutorum*, 7). As the eastern capital of Rome during Diocletian's reforms of the Tetrarchy, Nicomedia underwent a major architectural transformation to preserve the Hellenistic heritage of the region (Marcellinus, A., *Res Gestae*, 22.9.1). A large palace complex, Roman forum, hippodrome, theatre, baths and many pagan temples were built in the city. Especially the Palace of Diocletian was built as an eastern analogue of the imperial palaces in Rome.

In this palimpsest urban texture, it is seen that the temples of the polytheistic period and the temples of the monotheistic Christian and Muslim societies were built on top of each other. While it was an Acropolis-centred settlement in the Hellenistic period, it became an administrative and commercial centre in the Roman period, choosing a settlement close to the coast based on a grid plan. The city descended to the shore during the Roman period and the shore of the city has gained a spatial configuration that extends from the shipyard to the place where the wetland area begins, where the Pertev Pasha mosque is located today.



Figure 8. The relationship between the city of Nicomedia and the coast (Sirtcantam Issue 47)

With the transition of the Roman Republic to Imperial rule by Augustus in 27 BC, emperors were elevated to the status of gods. The fact that Augustus was called 'Theos Sebastos' (God Augustus) shows that he was deified while he was alive (Gülbay, 2009, p. 65). Emperor Augustus wanted the temples to be built during his reign to be more spectacular than other temples, and he wanted stone and marble to be used instead of wood (Tereman, 2007, p. 100). Augustus, who wanted to establish authority through the cult of the emperor, first granted the permission to establish a cult in Western Anatolia to the cities of Nikomedia, Pergamon, Ephesos and Nikaia and crowned these cities with the title of neokoros (Donaldson, 1859, p. 135).

According to the information obtained from ancient sources, coins and historians, a number of monumental buildings and temples were built in the city after it became the Roman capital. However, Nicomedia is one of the cities that received the title of neokoros with the emperor cult that started in the Augustus Period, and it became neokoros three times during the reigns of Augustus, Commodos and Elagabalus. This situation points to the existence of emperor temples built in the name of Augustus, Commodos and Helen Elagabalus in Nikomedia.

The first coins of Rome began to be minted in the early 3rd century BC, during the Republican Period of Rome. With the Roman emperor Augustus, architectural depictions and visual elements began to be used on coins, and in this period, depictions associated with the title of neokoros began to be seen on coins minted at the Nicomedia mint. Despite the depictions associated with the title of neokoros, temple depictions were added to these depictions during the reign of Hadrian. In addition to these depictions on coins made of gold, silver and bronze; depictions such as emperor-empress, god-goddess portraits, animal and plant motifs, temples, harbours, bridges, baths were also made (Tekdemir, N. 2016).

The city of Nicomedia, which was enriched with the fiction of temples dedicated to local Anatolian gods and Roman temples, increased its splendour with public monumental buildings after Emperor Diocletian chose Nicomedia as the capital. Bosh's plan shows two emperor temples and the temple of Demeter in the centre. In the 49th of Pliny's letters to Emperor Trajan, he reported that a new one was added to the old forum and that there was a temple of Demeter in the corner of this forum, and that this temple should be moved to another point due to construction, and in the 33rd letter, he reported that the Temple of Isis was destroyed in the fire. The torso analysed by S. Sezin Sezer in her study "Sculpture Works from the Ancient City of Nikomedia" suggests that there was an Asclepion Temple in the city. On the map of Nikomedia created by Sencer Şahin, the Temple of Demeter is located in Kozluk Neighbourhood. Libanius mentions that the Temple of Demeter was located on the hillside and connected to the harbour by a colonnaded street, and that a second main street extended through the city (Zeyrek, 2005, p. 49). It is also known that the gods Sabazios, Hera, Heracles, Zeus, Ares, Dionysus, Aphrodite, Eros, Athena, Apollo, Sarapis, Men and Priapos were worshipped in Nikomedia (Girgin, 2012).

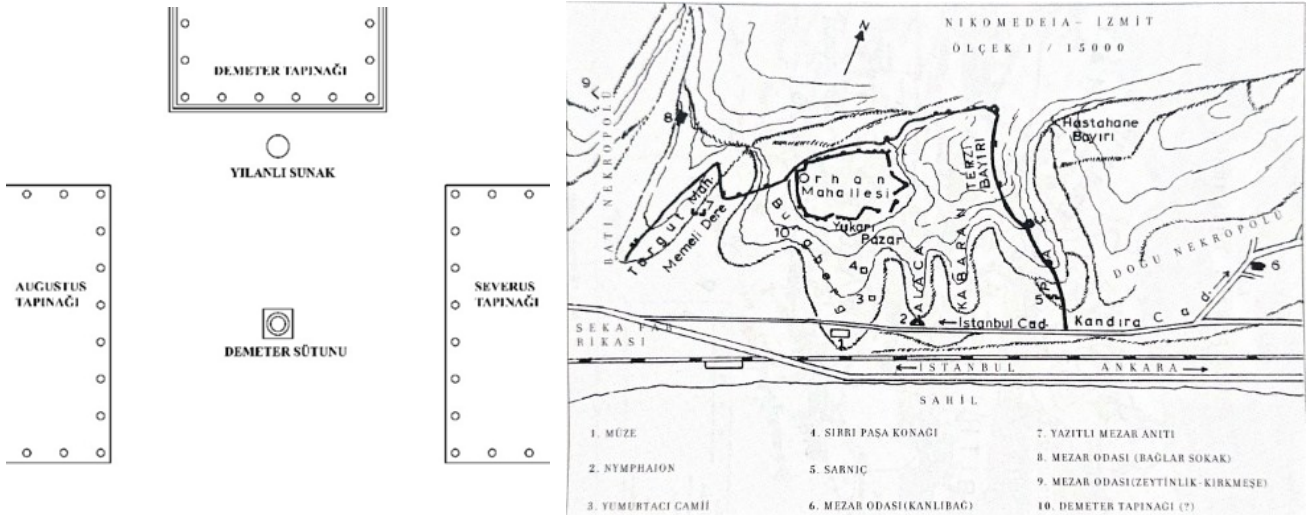


Figure 9. Bosch's plan showing the Emperor Temples and the Temple of Demeter and Sencer Şahin's city map

The depictions on the coins and archaeological data show the existence of the Temple of Demeter and two Emperor Temples in Nikomedia. The temple with eight columns on its facade found on the coins of the Hadrianic Period in Nikomedia is thought to be the Temple of Augustus, which was destroyed in the earthquake and restored during the Hadrianic Period (Zeyrek, 2005, p. 26). The temple structures most frequently depicted on these coins are the Demeter Column and the Temple of Demeter in the centre, the temple of the emperor on both sides and the colonnaded street leading down to the harbour. Bosch describes this layout as follows: "In the centre rises a monumental column decorated with the statue of Demeter, on one side of the Demeter column stands the Temple of Augustus and on the other side the Temple of Severus. The Temple of Demeter, which was later converted into the temple of the emperor, is in the centre. The altar is located just in front of the Temple of Demeter" (Bosch, 1937; p. 217).

The coins minted in Nikomedia generally depict a podium with six columns and 3 crepis (steps) on the facade of the Temple of the Goddess Demeter. Emperor temples are depicted with eight columns. Nevertheless, there are differences between the coins. Some depict the emperor temples with four columns, while the Temple of Demeter has two columns. These differences are the result of the transmission and depiction of the artist who minted the coin.

Discussion and Conclusion

Religion is a social institution that makes people believe in God, supernatural or sacred beings and adopt systematisation by worshipping in this direction (Akalın, 2009, p.531). At the same time, there is the act of forming its own society by keeping people belonging to the same religion under its patronage and imposing certain lifestyles. These societies started structuring their religious rituals by building sacred places specific to their religion and beliefs with the transition to settled life. This concept was formulated in a rational way in Sumer, which was perceived with certain rules, in Greece, which tried to make sense of religion with philosophy, or in Rome, which was shaped according to social needs.

Religious practices during the Roman Period were a programme organised in the name of social needs and the facilitation of administration. For this reason, they developed a political understanding that changed the names of the gods of the civilisations they dominated and added them to their own pantheon. After Emperor Augustus became the head of the Roman Republic in 27 BC and turned the administration into an imperial system, he rapidly spread the emperor cult in order to implement his policies smoothly (Zanker, 2010, pp. 304, 297). He declared himself as *divi filius* and took the title of the child of God, in this case, he was not the representative of God on earth, but God himself (Yurtsever, 2015, p. 13) and considered himself close to the patron god Apollo (Albasan, I, 2020). With this religious propaganda, he gave a special status to the cities he determined with the title of *neokoros* by making the emperor cult. With this status, cities were granted the privileges of hosting festivals and being exempt from taxation. This system was continued by other emperors and some cities increased their prestige by receiving the title of *neokoros* many times. In Western Anatolia, major cities such as Izmir (Smyra), Ephesus (Ephesus), Pergamon (Pergamon) and Izmit (Nicomedia) were honoured with the title of *neokoros* more than once. In addition, the main reason why about 30 of the 37 *neokoros* cities in the world were in Anatolia was to assimilate the Hellenic cities in Anatolia, which was called Asia Minor.

There are four Augustus temples in Anatolia. These are Ankara Augustus Temple, Burdur Sagalassos Augustus Temple, Kütahya Aizonai Augustus Temple and Isparta Pisidia Antiokheia Augustus Temple. The commonalities in the analyses of these four temples provide important clues for the remaining Augustan temples.

Feature	Aizanoi Augustus Temple	Ankara Augustus Temple	Sagalassos Augustus Temple	Antiokheia Augustus Temple
Location	Çavdarhisar (Kütahya)	Ulus (Ankara)	Sagalassos (Burdur-Ağlasun)	Pisidia Antiokheia (Isparta-Yalvaç)
Dedicated to God/Emperor	Zeus and Kybele	Emperor Augustus and the Roman goddess	Apollon Klarios and Emperor Augustus	Emperor Augustus
Date of Construction	2nd century AD (Hadrian period)	25–20 BC	End of the 1st century BC	Late 1st century BC
Architectural Plan	Pseudodipteros	Peripteros	Peripteros	With podium
Column Layout	Corinthian order	Corinthian order	Corinthian order	Corinthian order
Material	Marble and local stone	Local stone	Marble and local stone	Local stone
Podium Feature	High podium	High podium	High podium	High podium
Dimensions (approx.)	35 x 53 m	36 x 54 m	30 x 50 m	32 x 48 m
Inscriptions	Inscriptions dedicated to Hadrian	Res Gestae Divi Augusti (Latin and Greek)	Cult inscriptions and dedications to Apollo	Inscriptions belonging to the Augustus cult
Protection Status	Well preserved	Partially standing, inscription walls intact	Its foundations and some columns are still standing	Foundations and some blocks, some inscription fragments
Artistic Elements	Acanthus capitals, remains of statues in the crypt	Simple architecture, textual decoration in the foreground	Rich facade decorations, statues, altar ruins	Synthesis of Roman state architecture and local style
Facade Orientation	The temple was built on the southeast-northwest axis.	The temple was built on the north-east-south-west axis.	The temple was built on the east-west axis.	The temple was built on the southeast-northwest axis.

Table 1. Features of the four proven Augustus Temples in Anatolia

All four temples were built on a podium with local materials in the Corinthian order and orientated on an east-west axis. This is a common orientation in temple architecture unless there is a natural factor. The building was positioned by creating a sacred area with the temenos wall, and points close to the forum were chosen as the location of the temples. While the ancient city of Ankara, which houses the Temple of Augustus, is intertwined with the modern city, the temples in Isparta and Burdur and Kütahya are independent from the modern city. The main reason for this is the earthquake phenomenon. Cities located in the earthquake zone have experienced destruction in line with the tremors since the ancient period and the city has been reorganised and renovated. In the cities that are not in the earthquake zone, we see uninterrupted settlement since the ancient period and even the status of being a city centre. However, the cities in the earthquake zone appear as abandoned cities due to lack of geopolitical or economic conditions. In addition to these, cities located in the earthquake zone and at the same time at strategic points continue to urbanise despite all these negativities.

One of the best examples of this situation is modern İzmit, the ancient Roman capital of Nikomedia. The city is located around the western promontory, which is the natural harbour of the Marmara Sea, at a strategic point with geopolitical, economic and political advantages. Although it was previously established on the southern slope of this point, the city, which could not withstand the devastating earthquakes, was moved to the northern slope, to the city of Nicomedia, which developed approximately along the district borders of modern İzmit. Despite being located in a 1st degree earthquake zone, traces of the ancient city were traced and the modern city centre developed within the borders of the city of Nicomedia. The main reason for this is that the city is located at the most productive point in terms of geopolitics and economy, and it has assumed the identity of an industrial city with its natural harbour.

This situation has damaged the memory of the city to a great extent and caused the inhabitants to live unaware of the ancient city texture.

Nikomedia has not lost its importance from the day it was founded until today. The city has been renewed and stratified at periodic intervals due to the fact that the city has been subjected to periodic destruction and earthquakes. In this way, the traces of the previous city can be felt today. The most important of these traces are road axes and parcels. When the city typology is analysed in the light of these traces and ancient sources, the city has Hellenic characteristics in Dua Tepe, where it was founded as an acropolis, and after it came under Roman rule, it developed as a grid plan around the coast in accordance with the Roman city typology. Considering these road axes and parcels, İnönü Street, which is still in use today, *Cardo Maximus*, which divides the city of Nikomedia on the east-west axis, and Cumhuriyet Street, which is called the Walking Road, are ancient Roman streets. Another road developing between *Cardo Maximus* and the ancient harbour is the colonnaded street and in the light of ancient sources, the Demeter Altar and the Temple of Demeter meet us at the end of this road. With this definition, the Temple of Demeter is located in Kozluk Neighbourhood, as stated by Sencer Şahin on the city plan. Considering the relationship between the colonnaded road and the harbour, its approximate location is revealed. The Temple of Augustus, one of the rare Roman structures whose remains remain today, is located 300 metres north of Yenidoğan Mosque. This temple was destroyed in an earthquake during the reign of Emperor Hadrian and has been renovated several times. It is probable that the Temple of Severus was located at the eastern entrance of Nikomedia from İnönü Street, which Avni Öztüre labelled as the emperor's temple, in the area where Akça Mosque is located today. With these settlements, the relationship between the temples and the colonnaded street depicted on the coins and seen in Bosch's city plan emerges. The distance between the temples, which are very closely positioned on the coins, can be defined as a collage made by the minting artist in order to convey this relationship.



Figure 10. 1-Temple of Augustus, 2-Temple of Demeter, 3-Temple of Severus, 4-Eastern Entrance, 5-Main Street, 6-City Walls, 7-Acropolis Area, 8-Temple, 9-Palace, 10-Theater, 11-Temple, 12-Palace, 13-Hipodrome, 14- Roman Bath, 15-Palace, 16- Roman Bath, 17-Shipyard, 18-Agora, 19-Palace

Nikomedia was one of the first cities in Anatolia to host an imperial cult. This hosting started with the title of *neokoros*, which it received in 29 BC. Based on the remains, it is concluded that the orientation of the temple is north-west-south-east and the front facade is orientated towards the bay. According to the measurements of the temple wall made from Google Earth, the length of the temple is approximately 50 metres, in line with the other Augustus Temples. The pseudo peripteros, a common architectural element in the Roman period, is still visible on the side wall of the temple. Again, the presence of the platform read from this side wall shows that it was a classical Roman temple with a podium.



Figure 11. Location and situation of the Temple of Augustus in the Yenidoğan region of İzmit (obtained from Google Earth)

Although there are serious findings regarding the location and architecture of the temple with the information obtained as a result of the researches, on-site studies are inadequate. Currently, there is a distorted urbanisation on and on the spot where the Temple of Augustus is located. This situation causes the city dwellers to be unconscious about the place where they live and greatly damages the memory of the city. Within the scope of this study, the location and architectural elements of the Temple of Augustus in the city; ancient sources, other Augustus Temples proven by conclusive findings and ancient city-modern city traces were tried to be discussed, and it was aimed to increase the urban consciousness and the indicators that constitute urban consciousness.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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Chapter 15

Influence of European Modernism on the Housing Typology in Mexico

* Laura Buendia Ruiz

Introduction

The adaptation to the needs of different moments in history have continuously modified the built environment. Such adaptations have in time taken the form of new styles and new building typologies. In the case of Modernism, it was the result of the mechanization of part of the construction and of the necessary functionality to be able to provide housing to the rapidly increasing population.

Within the housing sphere, it was the German *Siedlung* in the 1930s that dominated the European thinking of housing planning as the modernist extension of the garden city (Ward, 2002). Although the Second World War interrupted its further development, the postulates of Modernism kept dictating the housing configuration and its immediate urban context after the end of the war (Monclús and Díez, 2015).

Architects like Ernst May, Bruno Taut, or Martin Wagner fully displayed their ideas through the first large *Siedlungen* and later, others –Le Corbusier, Walter Gropius –, took those concepts to larger scales of collective housing and spread them not only throughout Europe but also to other parts of the world, such as Mexico. The current paper is a thorough analysis of the development of modernist housing in Europe that later deepen in the influence of such movement in Mexican architecture. Examination of the existing literature as well as architectural and historical archives, along with visits and a photographic record, are the intended methods to complete the research. Such analysis aims to identify the built elements that remained as such in Mexico and those that changed according to the historical, social, and cultural context, and determine the extent to which the imported housing typology was adapted or its inhabitants adapted to it.

Existing literature review

Within the existing literature, there are various analyses of specific cases of modern housing development in Europe. However, there are very few comparisons, and those are mainly between European and rarely American study cases. Among the partial analyses of isolated cases in European cities, Fernández, Mosas and Ollero (a+t research groups) carried out a study of collective housing contributions in *10 Stories of Collective Housing* (2013), some of them following the ideas of Modernism. On the other hand, Eric Mumford (2002) addresses post-war urban planning and a new vision of socially engaged architecture within *The CIAM Discourse on Urbanism, 1928–1960*, which is the first complete history of CIAM. As for the specific studies of the *Siedlungen*, there is Pitz and Brenne's (1980) *Siedlung Onkel Tom, Berlin-Zehlendorf. Einfamilienreihenhäuser 1929 Architekt: Bruno Taut* [Single-family terraced houses 1929 Architect: Bruno Taut], as well as Dreyse's (1987) *May-Siedlungen. Architekturführer durch acht Siedlungen des neuen Frankfurt 1926-1930* [Architectural guide through eight *Siedlungen* of the new Frankfurt 1926-1930]. And finally, more recent research on how the modernist ideas of that time is still being applied and developed today, such as a reinterpretation of the *Existenzminimum* in contemporary housing solutions (Brysch, 2019), and New Perspectives on the II CIAM (Porotto and Monterumisi, 2019).

In terms of comparison analysis, in *Le monde des grands ensembles*, Dufaux and Fourcat (2004) compare French collective housing with other European cases as well as Asian and African examples. Such work presents large-scale

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How to Cite This Chapter:

Buendia Ruiz, L. (2025). Influence of European modernism on the housing typology in Mexico. In Rokhsaneh Rahbarianyazd & Hourakhsh Ahmad Nia (Eds.), *Resilient Heritage & Adaptive Urbanism* (pp. 183–190). Cinius Yayınları.
<https://doi.org/10.38027/N15ICCAUA20250082>

housing as an embodiment of a modern movement with global horizons and a circulation of ideas, and not merely as a French exception, for instance. Meanwhile, Stephen V. Ward (2002) makes a more global comparison within *Planning the Twentieth-Century City*, where he introduces the *Siedlungen* as the “modernist derivative of the garden city” and how the principles of Modernism were represented in the collective housing that spread throughout Europe and America as well, with its adjustments according to the different cultures and political situations. Among the most recent studies, Jugana Heikonen (2021) and her analysis of the influence of the *Siedlungen* on the Helsinki’s Prewar Housing Companies, shows that this approach is mainly through CIAMs and direct contacts with architects such as Alvar Aalto.

As for the Mexican case, all literature is almost entirely dedicated to a historical examination of the emergence of Modernism in the country and its different works, with only vague mentions of the movement’s influence from Europe, especially Le Corbusier.

Some of the most important works include Edward Burian’s (1988) *Modernidad y Arquitectura en México* [Modernism and Architecture in Mexico] and Fernanda Canales’s (2017) *Vivienda colectiva en México* [Collective housing in Mexico], which draws on her doctoral thesis research *La modernidad arquitectónica en México* [Architectural modernity in Mexico, 2013]. Similar to Canales’ thesis, most of the existing literature on this topic can be found as master or doctoral research; for instance, Lino Braganca’s (1986) *La vivienda y reproducción de la fuerza de trabajo: consumo de los objetos arquitectónico en Tlatelolco* [Housing and reproduction of the labor force: consumption of architectural objects in Tlatelolco], where it is mentioned the unequivocally influence of Athens Charter in the urban design of the first large collective housing; Hector Polanco’s (1991) *Los Conjuntos Habitacionales en el Desarrollo Urbano* [Housing Complexes in Urban Development], which affirms the new housing features as the introduction of Le Corbusier’s functionalism.

And finally, Enrique de Anda’s (2001) and Luis Manuel Chacon’s (2015) *Arquitectura Mexicana de la década del cuarenta: La construcción de la modernidad* [Mexican architecture of the forties: The construction of modernity] and *Arquitectura moderna en México* [Modern Architecture in Mexico] respectively which are the most comprehensive study of European modernism influence from a historical point of view. De Anda’s research, as it reads in its subtitle, *Los multifamiliares durante el alemanismo* [Housing complexes during Germanism], refers to the cultural crossroads with central Europe, and the influence of European architects living in the country like Hannes Meyer, as a capital condition for modernity in Mexico.

The most recent literature has introduced a few comparison studies as articles. Luca Ortelli (2014) makes a brief analysis of the main differences between the *Siedlungen* and the *Höfe*; meanwhile, Monclús and Díez (2015) review the development of collective housing in both western and eastern cities in Europe. Regarding Mexican architecture, Sánchez Rueda (2009) makes more detailed research of the architectural elements of collective housing, which reflect modernist ideas not only within the urban sphere but also within the housing typology. And finally, among the works that have approached the direct influence of modernist ideas, not only in Mexico but also in other countries of Latin America are the analysis of Juan Manuel Heredia (2014) *Mexico and CIAM. Notes to Mexican Modern Architecture History*, which investigates the little explored relationship between Mexico and CIAM through letters between Mexican architects and figures of the European movement such as Walter Gropius and Sigfried Giedion; Jaime Sarmiento’s analysis (2024), which names the precepts of the Athens Charter of the 1933 CIAM Congress as one of the most important influences for the emergence and conformation of the so-called multifamily housing in Mexico; and the research of Jorge Correa (2018), who reviews the development of the concept of minimum housing in Colombia.

Key findings of Modernism in Europe

In the last century, the rapid urbanization of the cities around the globe caused an increasing demand for built space to live in. National immigration to the most industrialized cities was one of the main reasons for such urbanization, leading to a housing shortage, mainly for the low-income classes. Therefore, experiments were carried out to find an adequate and prompt solution. In the case of Germany, for instance, the situation was even more serious considering the financial and moral crisis at the end of the war, the construction and adequate standards of workers’ housing was the major problem, in addition to the need to break with the rigidity of the urban fabric under the rule of the *Mietskaserne* (Arredondo, 2018). And it was in Berlin and Frankfurt where the experiments led to the creation of the *Siedlungen*, one of the first approaches to deal with the housing problem. These *Siedlungen* were originally settlements in border areas and agricultural colonies, the most common of which took the form of a circle or semi-circle for security reasons, and its configuration would stimulate the link between the new neighborhood-cities and the housing space of reduced dimensions but comfortable proportions – the *Existenzminimum* – (Carvahlo, 2021). This new typology was composed of continuous strips of houses from 3 to 5 levels, with both public and private

green spaces, creating a direct connection between the built and natural environment. One of the main features was the configuration of the apartments: standardized models that varied according to the size of the families. Such a configuration was a key point in the rationalism that architects were looking for, rationalism for construction that sought the maximum functionality of the spaces at more accessible prices for the inhabitants.

The so-called New Construction had clear lineaments such as speed of execution, mechanized and serial production, the incorporation of low-skilled construction trades, and the elimination of traditional crafts. For instance, within the construction processes, the use of an excavator and cranes was profitable for the first time, and there was also a more efficient way of transporting material, and a rational order of activities was regulated (Seelow, 2018). Among the architects in charge of the New Construction, Walter Gropius considered the means and organizational techniques as the goal for an adequate solution to offer dignified housing to the lower classes (van der Woude, 1999). As a result, architects became social beings, seeking not only an aesthetic ideal but also habitability and access to it to improve the quality of life of the inhabitants.

The idea of standardized housing and its rational construction became central arguments, which were thoroughly exposed thanks to the inauguration of the International Congress of Modern Architecture, CIAM, in Frankfurt in 1928. In the following years, the topics discussed were focused on the field, such as the minimum housing [*Die Wohnung für das Existenzminimum*], high-rise collective housing, and its urban planning to be inserted within the city (Molina Ramírez, 2014; Mumford, 2019; Porotto and Monterumisi, 2019). This last premise was included within the *Siedlungen* that are recognized as an early social urbanism that paid attention to issues such as the geopolitical structure of the city, the layout and density of buildings, the usefulness and need for green space, and the growth-transportation relationship (Bosch, 2020). Regarding the concept of the existential minimum, Ernst May, together with other collaborators such as architect Grette Schütte-Lihotzky, conducted functional, anthropometric, ergonomic, and perception studies to reduce the living space to a minimum while offering the maximum possible comfort at a reasonable price. This research also led to the *Frankfurter Küche* (Frankfurt kitchen) project, which would later lead to a different way of designing housing (Martínez and Díaz, 2018; Korbi and Migotto, 2019). And although Modernism and the growth of *Siedlungen* were interrupted by the Second World War, such ideas were reclaimed and developed after the conflict ended.

New residential units were designed throughout Europe and other countries following the premises of the Modernist movement. Its construction proliferated, especially from the end of the 1950s to the 1970s, with exceptional case studies in several cities, such as Sarcelles in Paris (Figure 1) and Bijlmermeer in Amsterdam (Figure 2), closely following the rationalist principles of the CIAM. The scale, however, was much larger compared to the *Siedlungen*, with housing blocks up to 14 levels, large green areas and recreational spaces between blocks, and services such as nurseries and laundries (Monclús and Díez, 2015). Modernism was fully displayed in both the architectural and urbanism spheres.

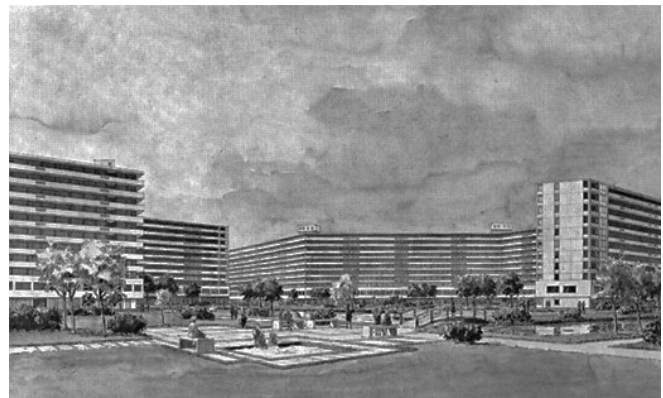


Figure 1. Sarcelles, Paris (Source: AFP) **Figure 2.** Bijlmermeer, Amsterdam (Source: Bijlmermuseum)

The influence of the movement initiated in Europe had a great reach, as it was in the case of Mexican architecture, thanks in part to architects who have studied or traveled to Europe and brought back such new knowledge, as well as the contributions of European architects who arrived in the country at that time.

Interpretation of key findings of the influence of Modernism in Mexico

In Mexico, as in Europe, immigration to the main cities between the 1920s and 1930s, due to better job opportunities, caused an accelerated urbanization and a great demand for housing. The government saw European modernity as a solution to the growing population's shelter needs, hoping that machines and technology would lead to mass progress (Sánchez, 2009). It was in the 1940s that the first housing units of the Modern Movement were built in Mexico; this typology is known in the country as *multifamiliar* (Gómez, 2022). One of the first projects, *Ciudad Obrera* [Worker City], followed rational urbanism, having a strong basis in the principles of the German *Siedlung*. The project consisted of unit blocks with 4 levels that housed 30 apartments each (Figure 3), a model that refers to some works by Ernst May. However, the project was not carried out due to the collectivization of some services, such as the kitchen and the children's bedrooms, a principle seen in the *dom-Komuna*, developed in the Soviet Union (Sánchez, 2009).

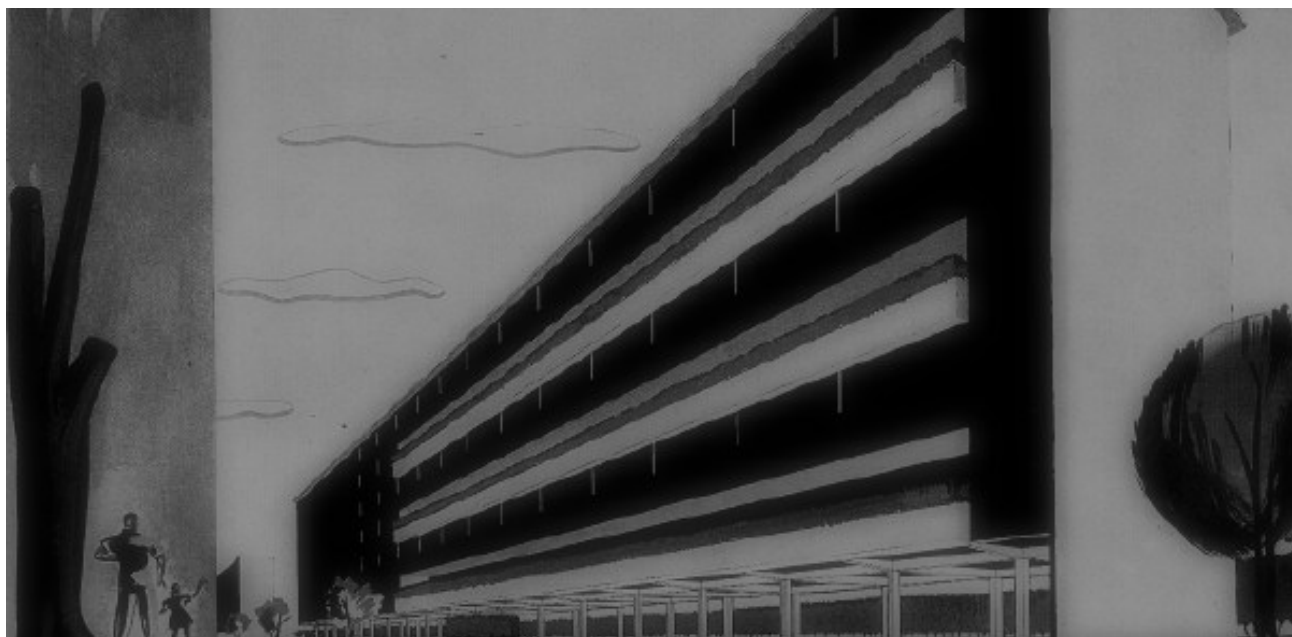


Figure 3. *Ciudad Obrera* (Source: UNAM magazine)

Nevertheless, the modernist ideals were eventually displayed both in teaching and in completed projects, and it was from the hands of architects who closely followed the movement in Europe. On the one hand, Swiss architect Hannes Meyer - director of the Bauhaus from 1928 to 1930 - came to Mexico to give a conference in 1938, later settled in the country and dedicated himself to teaching the new architecture (Rivadeneira, 1982). Among the projects of Meyer, one of the most relevant is the *Colonia Obrera* [Worker Neighborhood] to the west of the city (Figure 4).

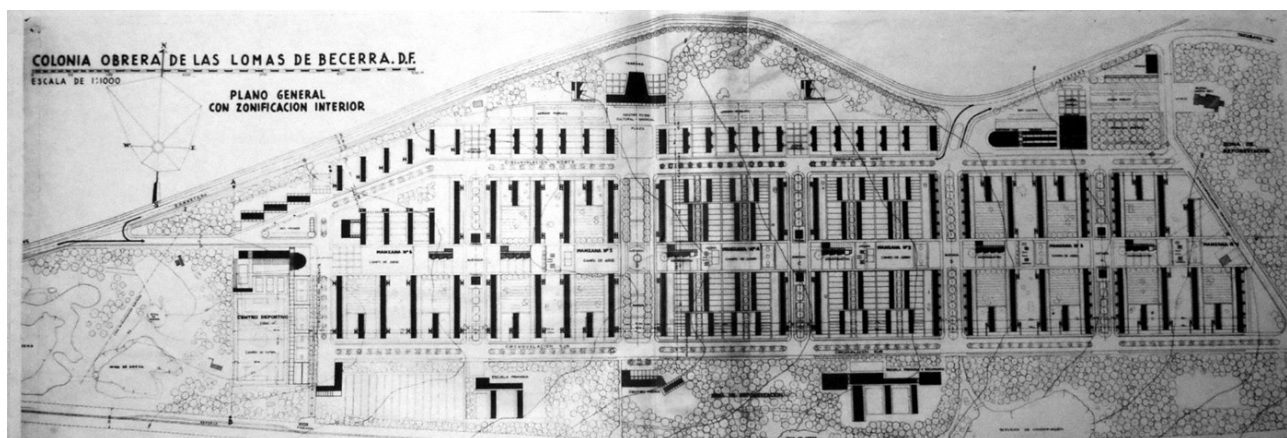


Figure 4. *Colonia Obrera* (Source: Stiftung Bauhaus Dessau)

The housing units were intended for workers from the Tolteca cement factory and the Eureka factory, which recalls the same purpose for which *Siemensstadt* was built. The unit consisted of rows of housing blocks linked to the central area by a 40-meter green pedestrian axis, along which the recreational spaces and schools were located. The blocks had 3 and 4 levels with 4-bedroom apartments of the same typology. The rationalist design based on the *Siedlungen* is evident: typified, systematic, and normalized design of the blocks, emphasizing the orientations and adjustment to the urban context (Infonavit, 1988). Meyer advocated a more social role for architecture (Sarmiento, 2023), and while his teaching and ideas remained in the country, his socialist political stance - although never publicly expressed - was one of the main reasons that these projects remained only on paper. Looking at the master plan for Meyer's project, the influence of the configuration schemes of Ernst May is evident. In 1930, May published in the magazine *Das Neue Frankfurt* a synthesis of the dense Berlin blocks (Figure 5), where the single- and double-row schemes stand out, where multi-storey buildings with grouped housing predominate (Bosch, 2024).

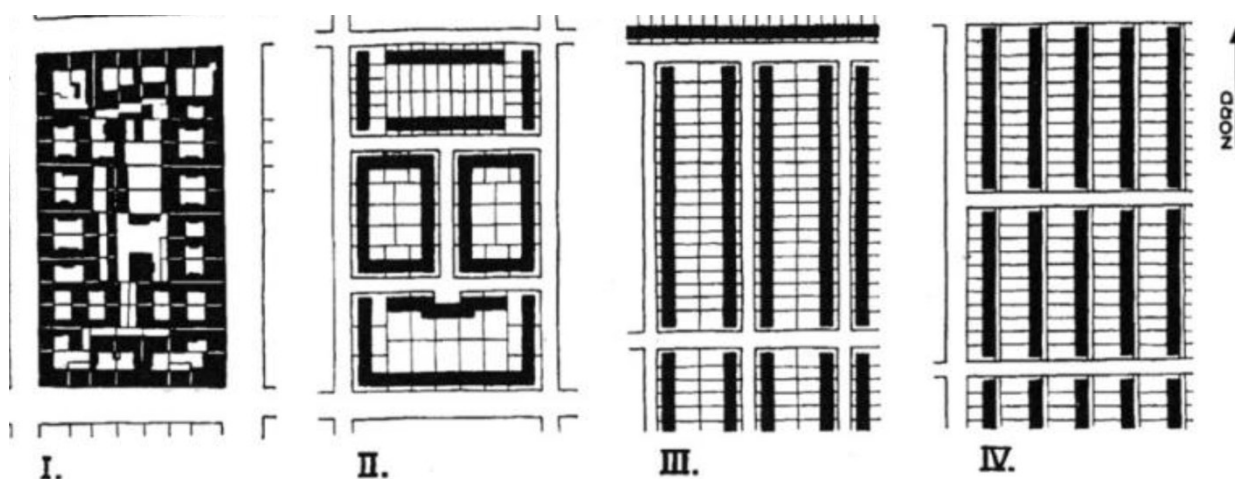


Figure 5. Synthesis of the dense Berlin blocks (Source: May, E., 1930)

With increased awareness of Modernism in the country, thanks in part to Meyer's efforts, the construction of housing superblocks was on the rise, particularly in the works of Mario Pani. Pani studied architecture at the Paris École des Beaux-Arts between 1929 and 1934, a time when Le Corbusier was pointing his architectural proposals in an urban direction, for example, with the *Ville Radieuse* (Figure 6).



Figure 6. Ville Radieuse (Source: archdaily)

Pani developed three of the largest housing blocks in the country (Figures 7-8), also introducing the concept of high-rise buildings, favoring the use of land for large green areas and disconnecting pedestrian and vehicular circulation (de Garay, 2010). Apart from the standardized design of the minimum dwelling with a reduced typology, which allowed for faster and more affordable construction. Within the urban sphere, however, such housing blocks were built within the city and not on the outskirts to expand the city and create new urban developments, as was the case in European cities (Sánchez Rueda, 2009). Pani wanted to create what he called “urban cells” interconnected by parks and organized around an administrative and commercial center, that is, with an autonomous structure. It was, as he called it, the first stage of an integral program for the city's problems, whose final solution would be a communications network of such cells (Valenzuela-Aguilera, 2020).



Figure 7. *Miguel Alemán*, housing blocks, units designed by Mario Pani (Source: arquine)

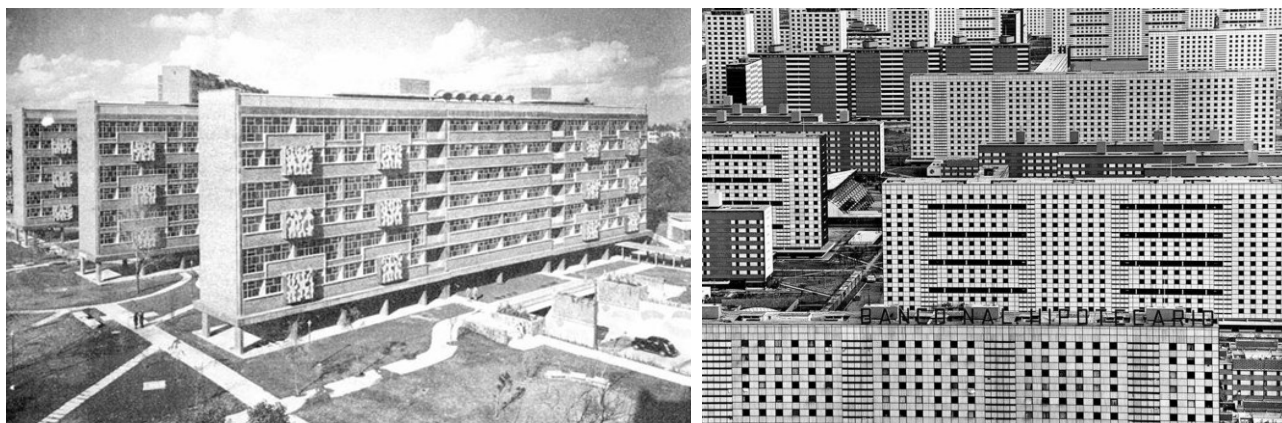


Figure 8. *Presidente Juárez*, and *Tlateloco* housing blocks, units designed by Mario Pani (Source: arquine)

Conclusions

In summary, within the existing literature, the clear influence of the principles of Modernism in architecture that emerged in Europe is evident, but it is simply mentioned and ambiguously analyzed. Furthermore, although similarities and differences in both housing and urban design may be apparent immediately, there are plenty of details that can be analyzed and questions to be asked and answered. For instance, which elements were straight imported and built but had a different outcome or effect on the inhabitants? What were those effects? Which spaces couldn't find a place in the new context?

Through this brief analysis, the ideas of Modernism applied to the development of housing in Mexico are clear. However, more detailed research is necessary to know to what extent such ideas arrived without any change and to what extent they were modified to adapt to the national context according to the social and economic moment. And there are even more questions that can arise in this regard: did this new typology have the same effects? Is it possible to reach a universal typology? And going even to the present moment: does this architecture still respond to the life of today's society? Can it be adjusted to current needs?

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The author(s) declare(s) no conflict of interest.

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