

# A Concept for the Digital Preservation and Popularization of Modernist Architectural Heritage: The Case of Kazakhstan

Zhanarbek Beristenov<sup>1</sup>, Erlan Baikulakov<sup>2</sup>, Erkin Makashev<sup>3</sup>, Zholdas Baymbetov<sup>3</sup>,  
Zhanerke Imanbayeva<sup>4</sup>, Dauren Mukhamejanov<sup>5,\*</sup>

<sup>1</sup>Department of Publishing, Editorial and Design Art, Kazakh National Academy named after Al-Farabi, Kazakhstan

<sup>2</sup>Department of Design, National Pedagogical University named after Abai, Kazakhstan

<sup>3</sup>Educational Program "Design and Technologies", Korkyt Ata Kyzylorda University, Kazakhstan

<sup>4</sup>Faculty of Design, International Educational Corporation, Kazakhstan

<sup>5</sup>Faculty of Architecture International Educational Corporation, Kazakhstan

*Received July 12, 2025; Revised October 30, 2025; Accepted November 19, 2025*

## **Cite This Paper in the Following Citation Styles**

**(a):** [1] Zhanarbek Beristenov, Erlan Baikulakov, Erkin Makashev, Zholdas Baymbetov, Zhanerke Imanbayeva, Dauren Mukhamejanov, "A Concept for the Digital Preservation and Popularization of Modernist Architectural Heritage: The Case of Kazakhstan," *Civil Engineering and Architecture*, Vol. 14, No. 1, pp. 70 - 81, 2026. DOI: 10.13189/cea.2026.140105.

**(b):** Zhanarbek Beristenov, Erlan Baikulakov, Erkin Makashev, Zholdas Baymbetov, Zhanerke Imanbayeva, Dauren Mukhamejanov (2026). *A Concept for the Digital Preservation and Popularization of Modernist Architectural Heritage: The Case of Kazakhstan*. *Civil Engineering and Architecture*, 14(1), 70 - 81. DOI: 10.13189/cea.2026.140105.

Copyright©2026 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

**Abstract** The present study addresses the pressing challenge of documenting and digitally representing the modern architectural heritage of Almaty—a city undergoing rapid urban transformation. Particular attention is given to Soviet-era modernist architecture, which is currently at risk due to privatization, uncontrolled renovations, and the absence of state regulation. The aim of the study is to develop a conceptual model for the digital reconstruction and popularization of one of Kazakhstan's key modernist architectural landmarks—the Asem House of Everyday Services in Almaty. The methodological design integrates documentary analysis (including scholarly literature, online sources, and an interview with the building's original architect) with strategies for expert and public engagement, encompassing consultations with architects, researchers, and practitioners associated with the Archcode Almaty project. As a result, a theoretical model of comprehensive digital preservation has been developed, incorporating a 3D model of the building, a virtual tour, panoramic interior views, and supplementary textual and audio materials, all integrated into an interactive online platform. This approach not only ensures

virtual accessibility but also contributes to heritage conservation, civic engagement, and educational reinterpretation. The principal contribution of the study lies in the creation of a scalable model for the digital representation of modernist architecture, applicable to other urban contexts across Kazakhstan. The research underscores the significance of digital technologies as instruments for sustainable cultural development and for strengthening public awareness of architectural identity. The novelty of the work stems from its integration of architectural analysis, digital modeling, and cultural interpretation within a unified and accessible format. Certain limitations are acknowledged, including dependence on archival sources and the necessity of interdisciplinary collaboration. From a practical standpoint, the proposed model holds considerable potential for application within heritage preservation programs, digital tourism initiatives, and architectural education.

**Keywords** Concept, Digital Technologies, Modernism, Popularization, Architectural Heritage

---

## 1. Introduction

Modernist architecture in Almaty represents a significant strand of Soviet architectural modernism, distinguished by its pronounced regional specificity and its key role in shaping the city's spatial and visual identity. In the context of ongoing urban transformations and globalization processes, developing strategies for preserving this architectural legacy acquires particular importance within cultural and urban policy agendas. During the 1960s–1980s, Almaty and other cities across Kazakhstan saw the implementation of large-scale architectural projects characterized by high compositional, artistic, and urban planning value. These buildings became integral elements of the cultural and visual landscape of the republic. Structures created within the Almaty school of modernism occupy a special place not only in Kazakhstan's architectural history but across the post-Soviet space, notably due to the use of then-innovative design solutions, such as fully glazed facades of public buildings [1]. A distinctive feature of these architectural objects is not only their technological innovation but also their deep integration into the regional context. Architects took into account the climatic conditions of southern Kazakhstan, incorporating passive solar protection, internal courtyards, and natural ventilation and thermal regulation systems [2]. The visual language of Almaty modernism actively drew upon local cultural codes—from the metaphors of the yurt to ornamental motifs on facades—while the city's natural environment, including abundant greenery and proximity to mountain ranges, contributed to the formation of a unique architectural identity [3, 4] (Figure 1).

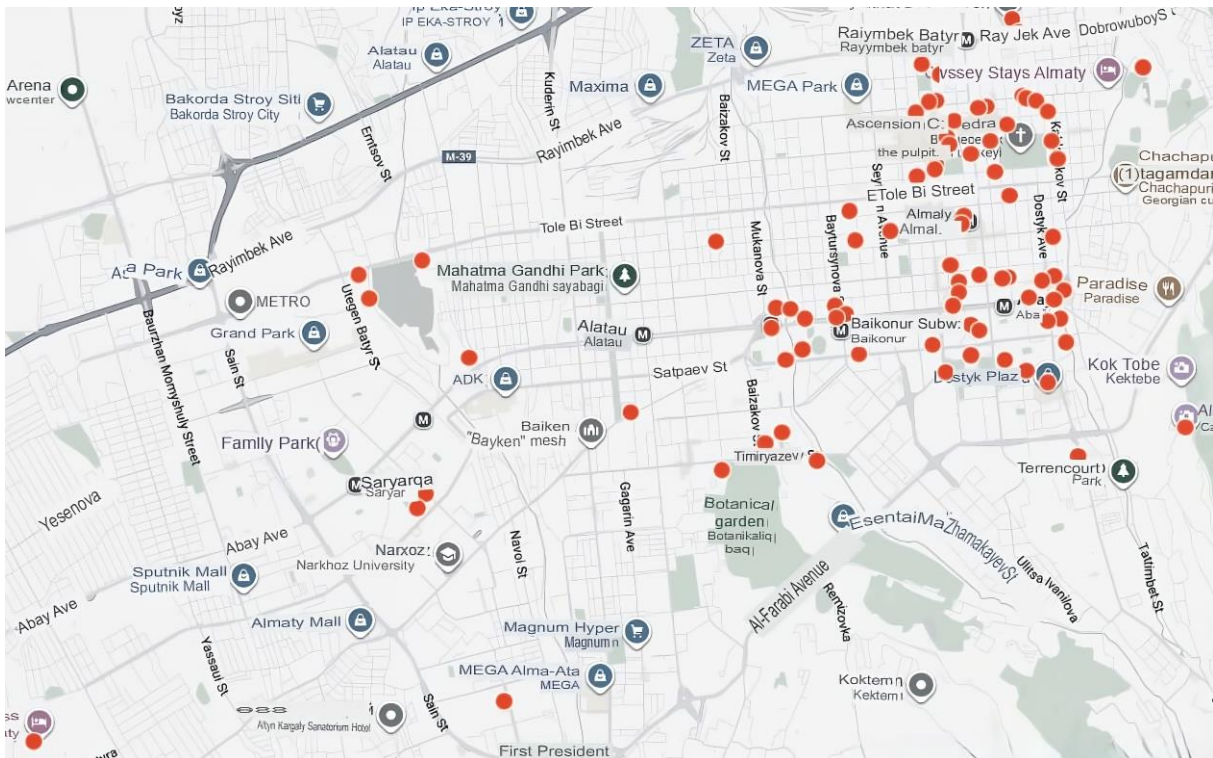
Despite its architectural and cultural value, Almaty's modernist heritage remains vulnerable: the absence of effective legal protection mechanisms, along with reconstructions and demolitions that result in the loss of authentic elements, poses a serious threat to its preservation. The research project Archcode Almaty (<https://archcode.kz/lecture>) provides information on the state of preservation of modernist sites, documenting cases of architectural identity loss following reconstruction, as well as complete demolitions (Figure 2). Archcode Almaty is a civic initiative and research project launched by practicing architects. Its official platform provides data on significant architectural objects in the city, including stylistic classifications, current condition, legal status, and an interactive map of the age distribution of the urban fabric. The platform also functions as a venue for lectures, seminars, and open forums, bringing together architects, urban planners, journalists, and engaged citizens. One of the project's key objectives is to raise awareness and stimulate public debate on the preservation of architectural heritage. In this regard, it is also important to highlight the activities of another independent civic foundation — Urban Forum Kazakhstan (<https://urbanforum.kz/partners->

and-experts). In practice, Urban Forum Kazakhstan carries out comprehensive studies of the urban environment, organizes public and expert events, conducts information campaigns, and builds a professional community and a nationwide network of urban initiatives. In addition, the foundation's website hosts a “Partners and Experts” section, featuring both Kazakhstani and international specialists and organizations, which demonstrates UFK's integration into global professional networks and confirms its expert status. The openness to collaboration and the successful work of initiatives such as Archcode Almaty and Urban Forum Kazakhstan have shaped an institutional ecosystem in Almaty conducive to the implementation of digital documentation strategies for modernist heritage. In this context, documenting the existing architectural stock becomes a critical component of strategies for preserving the historical and cultural urban environment [3]. Current methods of digital documentation make it possible to create highly accurate and information-rich digital representations of buildings, opening new opportunities for their conservation, research, and visualization [4].

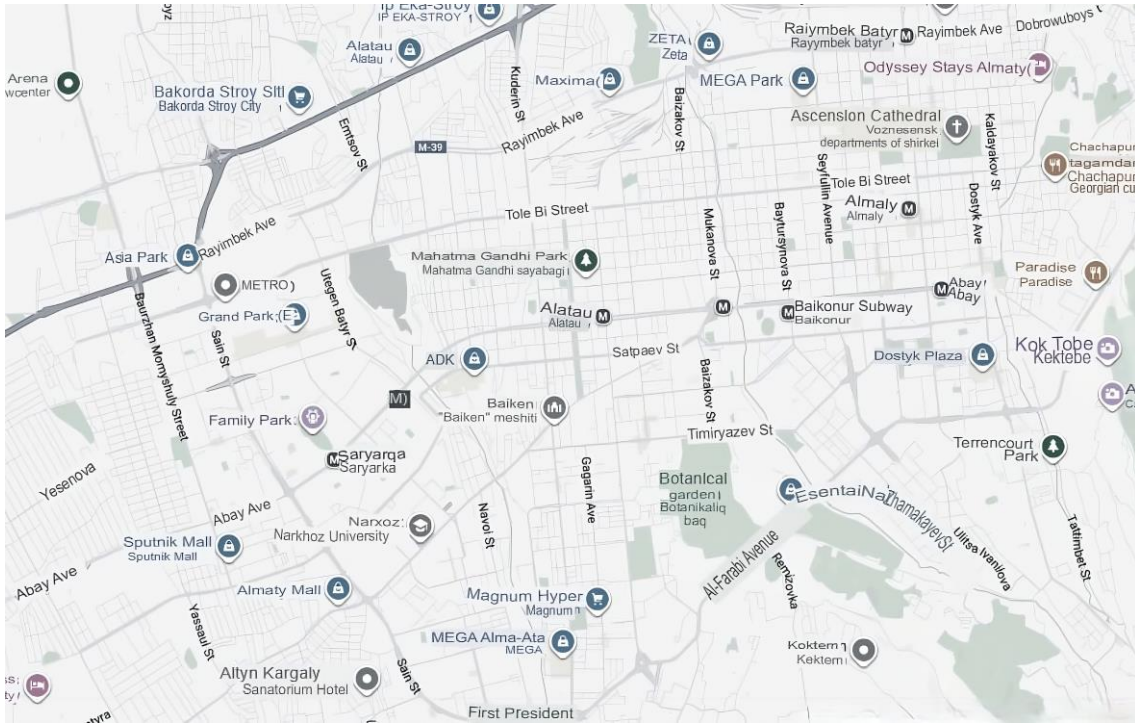
These approaches can also be integrated into educational programs, particularly through the use of architectural photogrammetry and digital technologies in the teaching of heritage-related disciplines [5,6,7]. Moreover, digital documentation strengthens the relationship between heritage objects and society, especially among younger audiences [8,9]. One of the most promising directions is the development of open digital platforms, such as virtual museums, specialized websites, and online archives, which ensure broad access to cultural information and its integration into public consciousness [10,11,12]. Thus, the digital documentation of modernist heritage can serve not only as a scientific and practical tool but also as a means of popularization and preservation under the pressures of contemporary urban development [13,14,15]. The aim of this study is to develop a conceptual proposal for the digital reconstruction and popularization of one of Kazakhstan's key modernist architectural objects—the Asem House of Everyday Services in Almaty. The proposed approach includes the creation of a virtual tour, a 3D model of the building, panoramic interior visualizations, and accompanying textual and audio materials to be published on the Archcode Almaty platform. The use of digital technologies in this context not only provides virtual access to the site but also contributes to its preservation, cultural representation, and integration into educational practices. The scholarly innovation of the research lies in the development of a scalable methodology for the digital representation of modernist architectural objects, which can be adapted to other cities in Kazakhstan that also possess significant examples of modernist heritage. The study underscores the importance of digital tools as instruments of sustainable cultural development and as mechanisms for fostering public responsibility and engagement in the preservation of architectural identity.



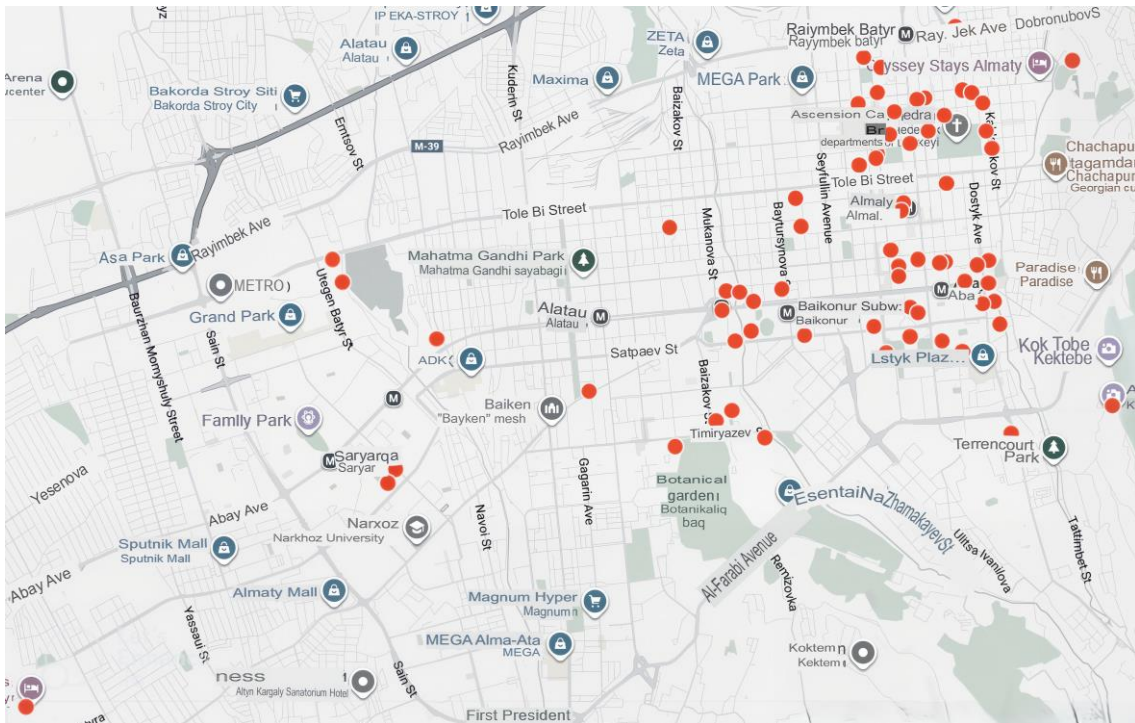
Figure 1. Examples of modernist architectural objects located in Almaty, Kazakhstan



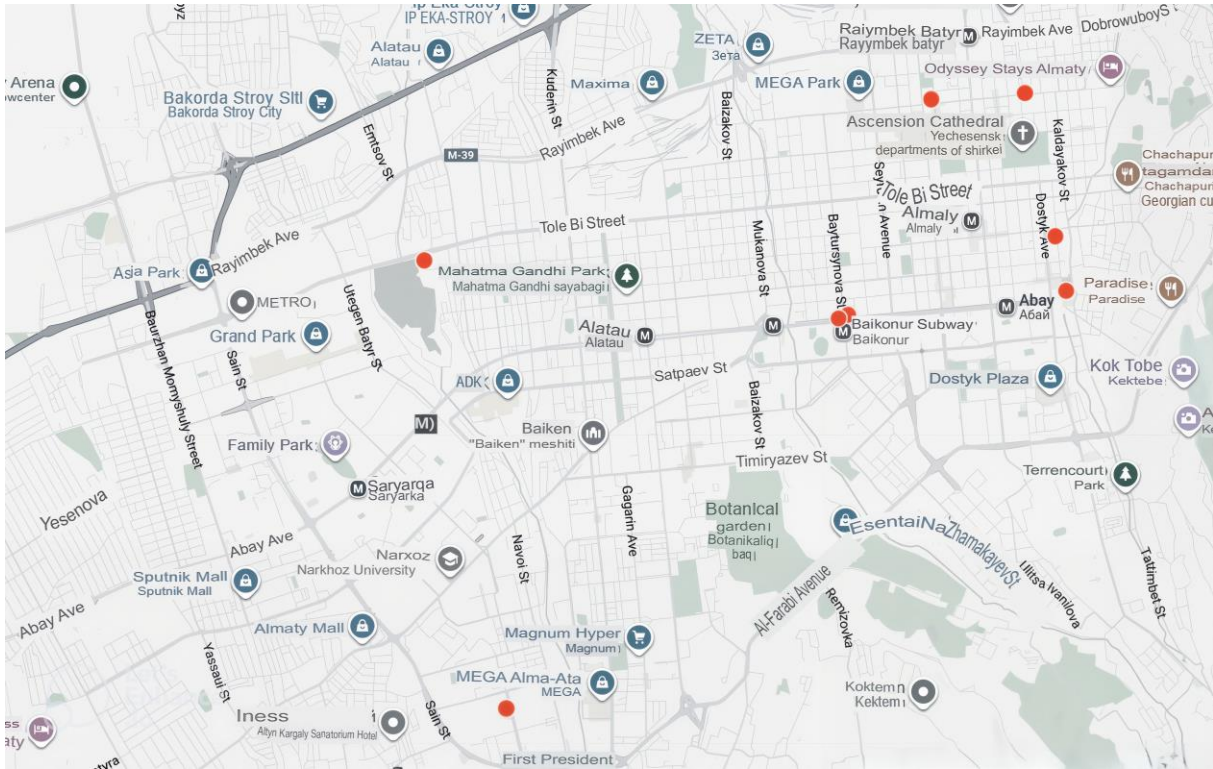
Architectural objects in the Modernist style in Almaty



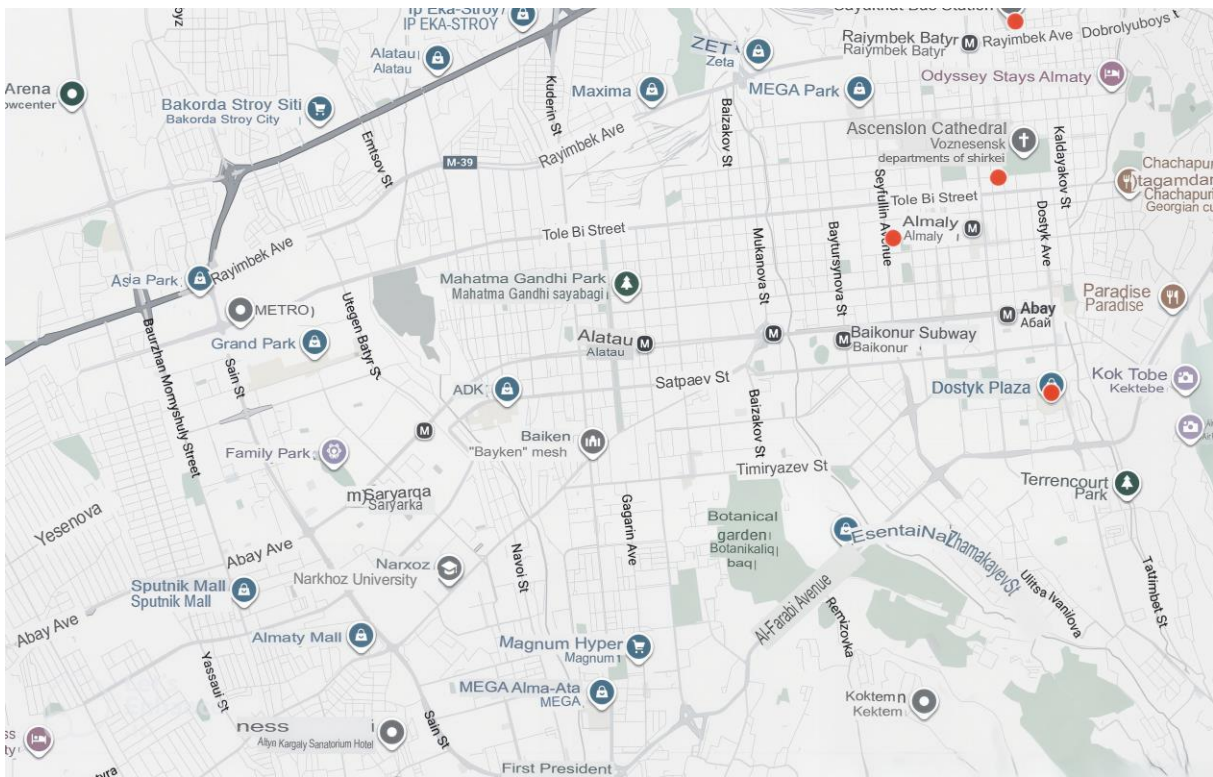
Preserved in its original form



Satisfactory preservation



Completely lost architectural appearance (reconstruction)



Lost (complete demolition)

Figure 2. Preservation status map of modernist architectural objects in Almaty. Source: Archcode Almaty. <https://archcode.kz/lecture>

## 2. Materials and Methods

### 2.1. Architectural and Planning Solution of the *Asem* House of Everyday Services

During the Soviet period, Almaty—as well as other major cities across the post-Soviet space—developed an extensive and functionally differentiated system of public service enterprises that were architecturally integrated into the urban fabric. These facilities were primarily located on the ground floors of residential buildings and served the population by providing two main categories of services: everyday and occasional. The first category comprised services in regular demand—such as hair salons, dry cleaning points, photo studios, and shoe repair workshops—distributed evenly across the city. The second category included services requiring less frequent use: custom tailoring, repair of large household appliances, furniture manufacturing, pawnshop services, etc. These less common functions were typically concentrated in specialized institutions known as “Houses of Everyday Services” (*Dom byta*), which were built according to projected demographic indicators and the functional needs of the urban environment. According to the official state register, the domestic services sector offered the population over a thousand types of services. One of the largest and most conceptually innovative examples of this category was the *Dom byta Asem*, designed in 1973 by the KazGiproNIIByt Design Institute. The building became not only a major service center—providing more than 300 types of services in two shifts with a staff of over 600—but also fulfilled an educational role, serving as a training base for young professionals from various regions of Kazakhstan in the field of public services (Figure 3). The space between the pavilions accommodated the main entrance and a gallery that linked the building to the market square. The culmination of the composition was a large-scale sculptural group—symbolic “hands” reaching toward the sky, placed atop the cantilevers; each sculpture weighed approximately 7.5 tons and bore both artistic and symbolic significance.



a)



b)

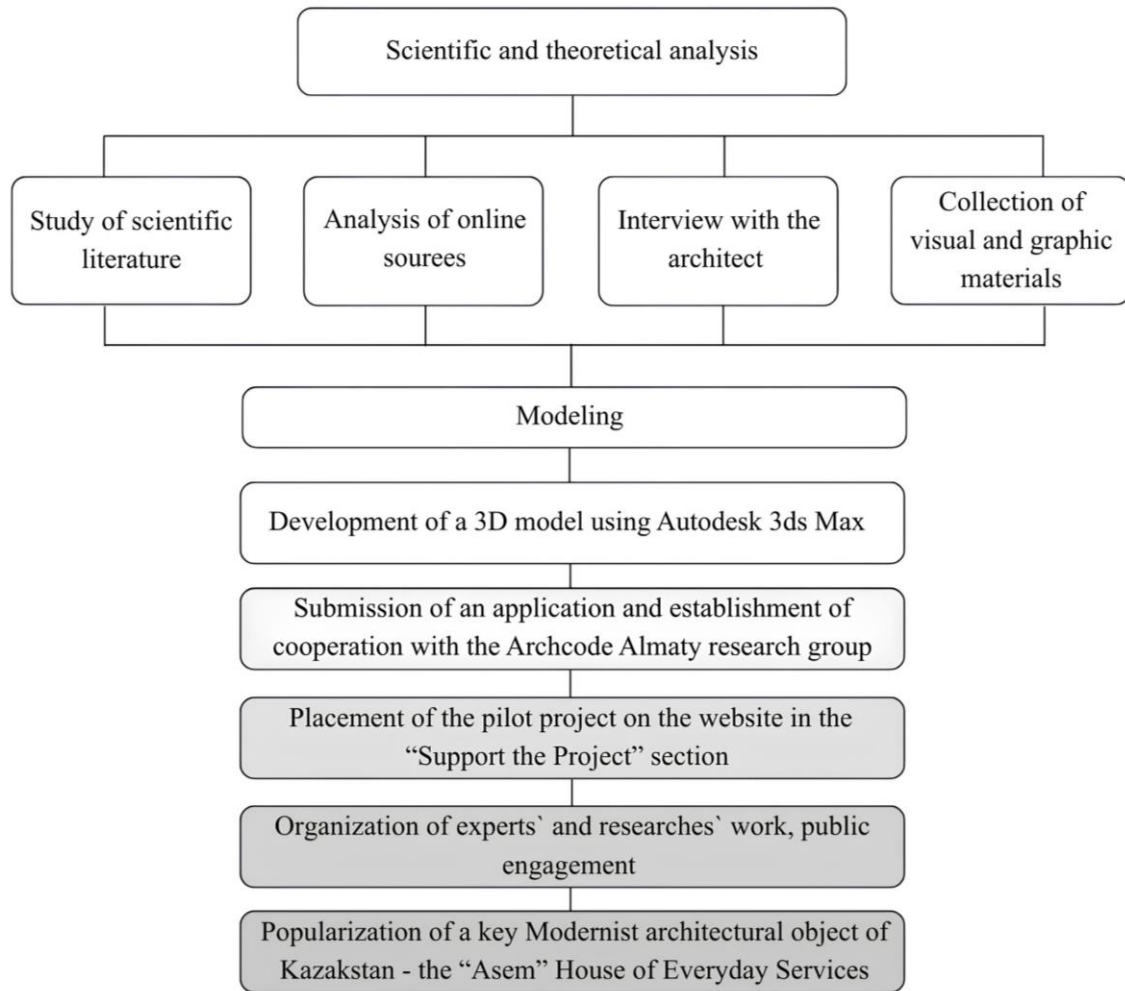
**Figure 3.** House of Everyday Services “Asem” (currently the “Megatau” Shopping Center) Architects: S. Kosmeridi, V. Alle. Year of Construction: 1976 (a) before reconstruction b) after reconstruction)

These vertical elements—stylized hands raised skyward—became the key symbolic accents in the building’s architectural image. This approach references the visual language of Le Corbusier, particularly his monumental project in Chandigarh. Despite a deviation in the installation of one sculpture, the architects achieved visual balance through the use of aluminum cladding, which added a sense of completeness and plastic integrity to the composition. The façade design was distinguished by a pronounced regional identity. A sun-shading system was implemented in the form of decorative lattices with geometric ornamentation inspired by traditional Eastern patterns. These elements not only protected the building from solar radiation but also added tectonic expressiveness, rhythm, and rich color to the façades. During reconstruction in the 2000s, these elements were removed, leading to the loss of the building’s authentic architectural appearance. Another major renovation in 2015 further altered the building’s exterior, erasing the original principles of the modernist composition. One of the most architecturally compelling aspects of the design was the adaptation to the site’s complex topography. With an elevation difference of up to 6 meters, the architects implemented a two-level esplanade: the upper level, facing Zhibek Zholy Street, included a second-floor balcony surrounded by a gallery, ensuring direct pedestrian access; the lower level featured a semi-open ground floor with stained glass windows that created a sense of visual permeability. This spatial solution supported both functional navigation and the harmonious integration of the building into the city’s topographical structure. The artistic character of the façades was further enhanced by modular rectangular panels bearing Eastern ornamentation, mounted on the upper levels. In the central section of the northern pavilion, four such modules were replaced with a bas-relief mosaic panel, adding an additional layer of artistic emphasis. Today, the building operates as the “Megatau” shopping center. It is located in the historic district of Almaty (Figure 3). Of particular importance for the study of the architectural transformation of the Asem complex is the position of architect S. G. Kosmeridi, who participated in its design. In one interview, the architect

shared his vision behind the design: the building was conceived as an open, multifunctional public space, organically integrated into the urban landscape. The spatial composition was closely connected to the site's terrain, emphasizing pedestrian accessibility, the visual permeability of the ground floor, and the symbolic content of the architectural image. Significant attention was given to local climate, creating a comfortable urban environment.

One of the key artistic and compositional elements of the project was the vertical structures between the pavilions—stylized hands reaching upward. These were designed as architectural accents, giving the building symbolic expressiveness and a memorable silhouette. According to Kosmeridi, this plastic metaphor referenced the visual language of Le Corbusier, particularly his monumental project in Chandigarh. Despite installation deviations in one of the sculptures, the architects managed to achieve visual balance through the application of aluminum cladding, which gave the composition a finished and cohesive appearance. In his interview, Kosmeridi expressed regret that subsequent renovations had stripped the building of the very elements that had shaped its architectural and semantic identity. The removal of stained-glass façades, decorative lattices, and the esplanade's spatial configuration severed the building's visual and symbolic ties to its historical and cultural context. What once was a complex, symbolically rich modernist object has become a commercial complex with a neutral architectural shell, stripped of its original artistic concept. Thus, the artistic and figurative interpretation of the architectural image of "Asem" is an invaluable source that reveals the deep values embedded in the project. It enables not only the reconstruction of the building's original ideological framework but also a critical reflection on the consequences of uncontrolled architectural transformations, highlighting the need for strategies of

documentation and representation of lost modernist heritage. The loss of the architectural identity of the House of Everyday Services "Asem" is confirmed not only through visual analysis but also by expert assessment from the Archcode Almaty research project, which specializes in documenting and systematizing Almaty's architectural heritage. On the project's official platform, the building is described as having "completely lost its original appearance," emphasizing the critical extent of its transformation and the irreversible losses to the city's architectural history. This assessment reflects the research community's recognition that, due to extensive reconstruction, the building can no longer be considered a bearer of modernist architectural aesthetics or cultural significance. In this context, "Asem" has transformed from an architectural heritage site into a depersonalized commercial structure, stripped of the spatial, artistic, and semantic qualities embedded in the authorial concept. The Archcode Almaty assessment not only performs a diagnostic function but also underlines the need for systematic documentation of such buildings before radical alterations take place. In this respect, digital documentation becomes particularly important as a means of preserving architectural memory—especially in cases where the physical substance of a building no longer retains historical authenticity. The involvement of research and public initiatives such as Archcode Almaty is an essential mechanism for developing alternative preservation practices—through digital representation, reconstruction, and educational formats that ensure continued access to the lost elements of the cultural landscape. Thus, this study integrates theoretical analysis, field observations, and digital modeling to identify the object's architectural, functional, and social features through source analysis, expert interviews, 3D modeling, and virtual-prototype testing in the urban context (Figure 4).



**Figure 4.** Diagram of the research methodology

### 3. Results

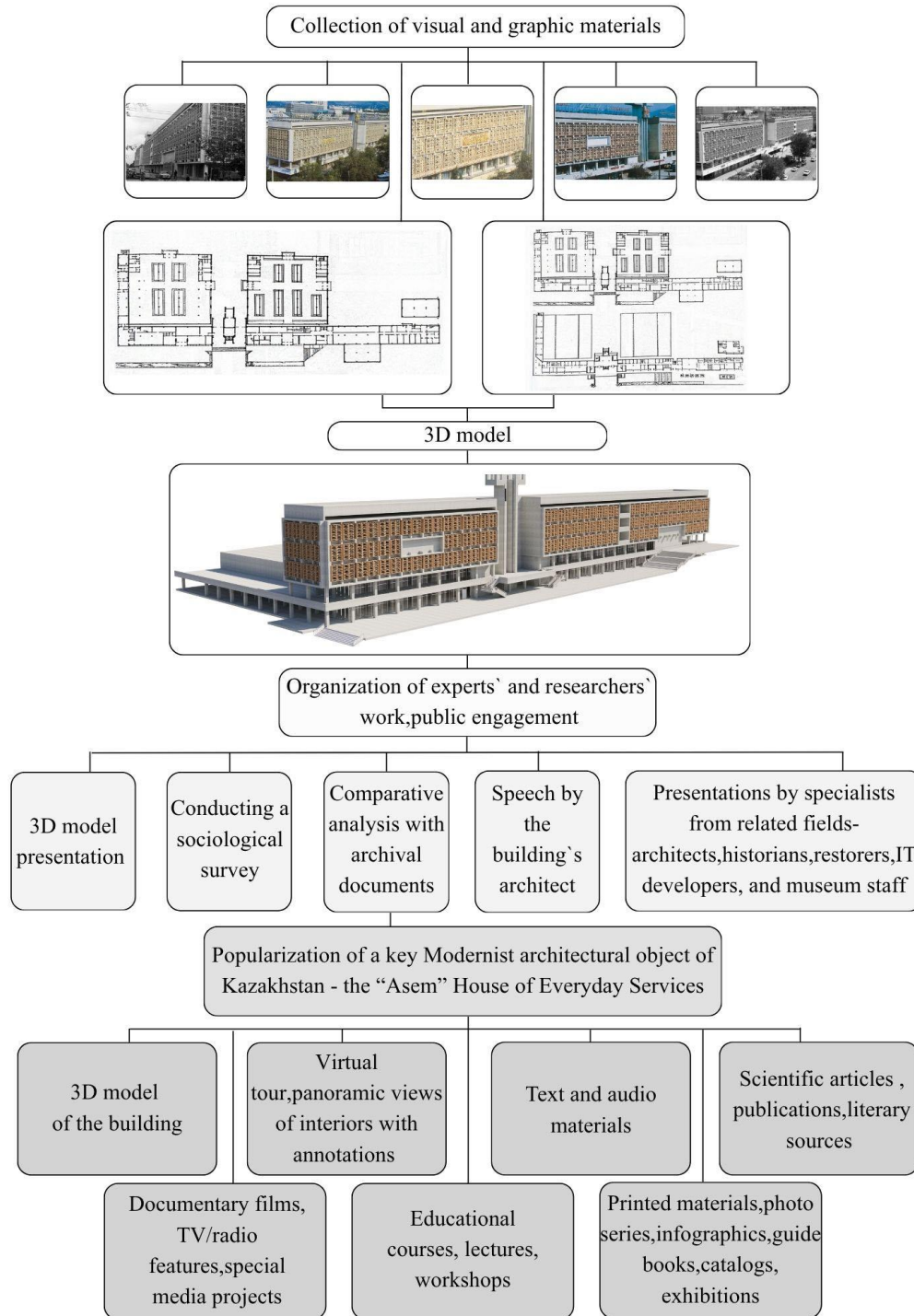
The 3D model of the House of Everyday Services *Asem* was created using Autodesk 3ds Max (Figure 5). At the initial stage, archival drawings and photographic materials were collected and digitized, forming the basis for constructing the building’s geometric structure. In the 3ds Max environment, the main volumetric and spatial elements were modeled — including the pavilions, cantilever structures, and façade lattices. To enhance the accuracy of the reconstruction, polygonal modeling methods were applied, with proportions adjusted using topographic data and photographs from the original construction period. Facade elements, including decorative panels and mosaic inserts, were recreated through texturing and the application of ornamental maps, which made it possible to approximate the visual perception of the building’s original appearance. In the final stage, lighting was configured and panoramic renderings of the interiors and exteriors were produced for integration into the virtual tour.

A comprehensive strategy for a scalable model of digital

reconstruction and popularization of modernist architectural objects.

- **Crowdsourcing as a source of empirical data.** The collection of visual and descriptive materials from a broad audience—including local residents, tourists, and architecture enthusiasts—in the form of photographs, narratives, video recordings, and personal memories from various periods and contexts, holds considerable potential for the reconstruction of lost or transformed architectural elements. However, such materials require expert validation and systematic digital processing.
- **Archival research.** The use of resources from public and private archives, including national library holdings, audiovisual repositories, museum collections, and digital archives, constitutes a critical phase in building a comprehensive documentary base.
- **Cartographic documentation.** Historical cadastral maps, general urban development plans, and topographic surveys enable the clarification of spatial parameters and the urban planning context of architectural sites.

- Architectural design documentation.** The original technical drawings provide key insights into the artistic and conceptual intent, including geometry, volumetric-spatial characteristics, and symbolic elements, which makes them indispensable for accurate digital modeling.
- Interdisciplinary collaboration.** Successful implementation of the project requires coordinated efforts by professionals from related fields—architects, historians, conservation specialists, IT developers, and museum professionals—to ensure a holistic and methodologically sound approach to digital model development.



**Figure 5.** Graphic model of a conceptual proposal for digital reconstruction and popularization of modernist architecture of Kazakhstan - House of Consumer Services "Asem" in Almaty

Priority actions for implementing a digital modernist preservation strategy include:

- Development and deployment of municipal or national programs for the digital inventory of modernist architectural heritage, with subsequent integration of 3D models into publicly accessible digital archives and databases;
- Initiation of cross-sectoral collaboration between professional architectural organizations, governmental bodies, and expert institutions to formulate regulatory and methodological frameworks for working with modernist architecture;
- Support for academic and educational initiatives aimed at the study, reinterpretation, and promotion of Soviet modernist heritage through scholarly publications, student research projects, and educational curricula;
- Organization of public communication formats—lecture series, thematic exhibitions, urban forums, and roundtables—to raise awareness and appreciation of postwar architecture;
- Active engagement of local communities in the processes of digital documentation and interpretation via crowdsourcing platforms, collecting visual, textual, and oral histories associated with specific architectural landmarks.
- Consequently, digital models of modernist architecture acquire the status of multifunctional resources, capable of serving analytical, educational, commemorative, and cultural visualization purposes. Their integration into open-access digital platforms, mobile applications, interactive urban maps, and museum exhibits ensures inclusive access to the visual and historical substance of lost or altered architectural forms for both specialists and the general public.

## 4. Discussion

The results of the study demonstrate that the proposed conceptual framework for digital reconstruction is an effective tool for the preservation of architectural heritage. This research is conceptual in nature and aims to establish methodological and analytical foundations for subsequent practical work in documenting, preserving, and digitally reconstructing the architectural heritage of Almaty. The focus is placed on developing conceptual approaches that can be applied in applied research and project initiatives, as well as adapted to other examples of modernist architecture in Kazakhstan. The findings will be presented to the leadership of the Archcode Almaty platform for inclusion in the “*Support the Project*” section. This will ensure the openness of the study to a wide professional audience and enable the engagement of architects, researchers, and the public in refining and testing the proposed solutions. In this way, the conceptual model of digital reconstruction goes

beyond the academic sphere, becoming the basis for practical implementation, the development of collective expertise, and the strengthening of public involvement in cultural heritage preservation [16,17]. Such positioning emphasizes the long-term orientation of the research, as well as its integration into the existing framework of cultural and urban policy [18]. The conceptual elaboration of digital reconstruction becomes a starting point for creating a comprehensive tool for preserving architectural modernism, one that unites research, educational, and civic practices [19,20].

The results also demonstrate the effectiveness of a comprehensive approach to the digital reconstruction of lost modernist heritage, exemplified by the case of the *Asem House of Everyday Services* in Almaty. The proposed concept integrates a wide range of methods and strategies—including crowdsourcing, archival research, cartographic and architectural documentation, interdisciplinary collaboration, and the direct involvement of the original architect in the process of digital representation.

The combination of these components has made it possible to create a reproducible and adaptable model of digital restoration, applicable not only to this case but also to other examples of modernist heritage in Kazakhstan. A comparison with existing international practices—*Scan the World*, *CyArk*, and *Reconstructing Palmyra*—demonstrates that the key to successful digital reconstruction lies in balancing technical precision with a deep interpretation of cultural and historical context [21,22,23]. The architect S. G. Kosmeridi took a personal part in this study - a sign of special originality. His personal knowledge and design intent provide a degree of authenticity that goes beyond formal modeling. Despite his advanced age, Kosmeridi remains an active bearer of the project’s conceptual vision, which enhances both the scientific credibility and ethical legitimacy of the reconstruction process.

The use of crowdsourcing as a tool for collecting empirical data helped to compensate for the lack of official documentation but also underscored the necessity of expert validation. This finding is consistent with contemporary studies in the field of digital heritage (e.g., R. Arora and M. Ioannides), which highlight the importance of integrating user-generated data with academic standards of quality assurance.

A particularly significant outcome of the study was the integration of the digital model into the Archcode Almaty platform. This step not only ensures public access to visual and textual materials but also contributes to the formation of a digital archive of Almaty’s vanishing architectural layers. This aligns with contemporary theories of digital public heritage, in which online representation is regarded as a means not only of preservation but also of reactivating historical experience within public consciousness. The practical recommendations developed in the course of the research—including the creation of a national digital

inventory program, cross-sectoral collaboration, support for educational initiatives, and the involvement of local communities—are aimed at building an institutional framework capable of protecting modernist architecture in the context of urban transformation [24,25,26]. These proposals are consistent with recommendations issued by ICOMOS and other international organizations working on heritage protection in rapidly changing urban environments. The conclusion confirms the initial hypothesis that digital reconstruction – with the support of experts, including designers and an interdisciplinary approach – can serve as a full-fledged achievement in preserving the isolation of identity [27]. It not only compensates for the physical loss of an object but also generates new formats for access, interpretation, and dialogue between society and its architectural heritage [28,29].

## 5. Conclusions

The conducted study has demonstrated that the development and implementation of digital strategies serve as an effective tool for the preservation and popularization of modernist architectural heritage in Kazakhstan. Using the case of the “Asem” House of Everyday Services in Almaty, the research presents an adaptable model of digital reconstruction based on an interdisciplinary approach, crowdsourced empirical data collection, archival and design document analysis, as well as the participation of the original architect, S.G. Kosmeridi. His continued professional engagement ensures both scientific accuracy and cultural continuity in the creation of the virtual model. The findings confirm the relevance of digital technologies not only as instruments for visualization and archiving, but also as mechanisms of sustainable cultural development, civic engagement, and recontextualization of lost elements within the architectural landscape. The integration of the digital prototype into the Archcode Almaty platform ensures public accessibility while contributing to the formation of a national digital archive of modernist heritage. The conceptual and practical approaches proposed in this study can be scaled to other cities in Kazakhstan, many of which possess significant examples of modernist architecture currently at risk of transformation or demolition. Establishing a systemic digital inventory platform, supporting academic and educational initiatives, and fostering cross-sectoral collaboration among professionals, public institutions, and civil society should form the foundation for a sustainable cultural policy toward the architectural legacy of the second half of the twentieth century. Thus, in the context of physical loss, digital reconstruction becomes an indispensable component of contemporary heritage preservation strategies. It not only records the vanished fabric but also restores its symbolic and visual presence within both the urban environment and collective memory.

---

## REFERENCES

- [1] Romashkina S., “Architectural guide to 12 Soviet buildings of the southern capital of Kazakhstan”, Archcode.kz, <https://archcode.kz/journal/view?category=projects&sefname=arhitekturnyj-gid-po-12-sovetskim-zdaniyam-uznoj-stol-icy-kazahstana>
- [2] Proskurin V., “Three Capitals in Faces: Verny, Alma-Ata, Almaty”, vernoye-almaty.kz, <https://vernoye-almaty.kz/a-z/13.shtml> (accessed May 5, 2025).
- [3] Rogers A.P., “Built heritage and development: Heritage Impact Assessment of Change in Asia”, *Built Heritage*, vol. 1, no. 1, pp. 16–28, 2017. DOI: <https://doi.org/10.1186/BF03545660>.
- [4] Turgut Gültekin N., “Evaluation of the Conservation of Modern Architectural Heritage through Ankara’s Public Buildings”, *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 245, pp. 082046, 2017. DOI: <https://doi.org/10.1088/1757-899X/245/8/082046>.
- [5] Bayati A.M., “Geo Digital Documentation (GDD) for Arab and Islamic Heritage Preservation”, *Int. J. Geomat. Geosci.*, vol. 2, no. 2, pp. 1–15, 2014. <https://openresearch.lsbu.ac.uk/item/87743>.
- [6] Baik A., Alitany A., “From architectural photogrammetry toward digital architectural heritage education”, *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, vol. XLII-2, pp. 49–54, 2018. DOI: <https://doi.org/10.5194/isprs-archives-XLII-2-49-2018>
- [7] Kolay S., “Cultural Heritage Preservation of Traditional Indian Art through Virtual New-media”, *Procedia – Social and Behavioral Sciences*, vol. 225, pp. 309–320, 2016. <https://doi.org/10.1016/j.sbspro.2016.06.030>
- [8] Chmielewski G., “Documentation and dissemination of Cultural Heritage: Current solutions and considerations about its digital implementation”, *Conference: 2013 Digital Heritage International Congress, Marseille, France, Oct. 28–Nov. 1, 2013*, pp. 555–562. DOI: <https://doi.org/10.1109/DigitalHeritage.2013.6743796>
- [9] Valentini M., Battini C., Vecchiattini R., “HBIM to Support the Executive Design of a Restoration. Critical Issues Related to Geometric and Semantic Modeling”, *SCIRES-IT – Scientific Research and Information Technology*, vol. 13, no. 2, pp. 125–136, 2023. DOI: <https://doi.org/10.2423/i22394303v13n2p125>
- [10] Vandesande A., van Balen K., Della Torre S., Cardoso F., “Preventive and planned conservation as a new management approach for built heritage: from a physical health check to empowering communities and activating (lost) traditions for local sustainable development”, *Journal of Cultural Heritage Management and Sustainable Development*, vol. 8, no. 2, pp. 78–81, 2018. DOI: <https://doi.org/10.1108/JCHMSD-05-2018-076>
- [11] Yeshwanth Kumar, A., Noufia, M. A., Shahira, K. A., and Ramiya, A. M., “Building information modelling of a multi storey building using terrestrial laser scanner and visualisation using potree: an open source point cloud renderer”, *Int. Arch. Photogramm. Remote Sens. Spatial Inf.*

- Sci., XLII-2/W17, pp. 421–426, 2019. DOI: <https://doi.org/10.5194/isprs-archives-XLII-2-W17-421-2019>.
- [12] Borri A., Corradi M., “Architectural heritage: A discussion on conservation and safety”, *Heritage*, vol. 2, no. 1, pp. 631–647, 2019. DOI: <https://doi.org/10.3390/heritage2010041>
- [13] Della Torre S., “Italian perspective on the planned preventive conservation of architectural heritage”, *Frontiers of Architectural Research*, vol. 10, no. 1, pp. 108–116, 2021. DOI: <https://doi.org/10.1016/j.foar.2020.07.008>
- [14] Castellano-Román M., Pinto-Puerto F., “Dimensions and levels of knowledge in heritage building information modelling, HBIM: The model of the Charterhouse of Jerez (Cádiz, Spain)”, *Digital Applications in Archaeology and Cultural Heritage*, vol. 14, p. e00110, 2019. DOI: <https://doi.org/10.1016/j.daach.2019.e00110>
- [15] Van Balen K., “The Nara Grid: An Evaluation Scheme Based on the Nara Document on Authenticity”, *APT Bulletin: The Journal of Preservation Technology*, vol. 49, pp. 39–45, 2008, URL: <https://ru.scribd.com/document/221409498/The-Nara-Grid-an-Evaluation-Scheme-Based-on-the-Nara-Document-on-Authenticity>
- [16] Aloisio A., Antonacci E., Fragiaco M., Alaggio R., “The recorded seismic response of the Santa Maria di Collemaggio basilica to low-intensity earthquakes”, *International Journal of Architectural Heritage*, vol. 15, pp. 229–247, 2021. DOI: <https://doi.org/10.1080/15583058.2020.1802533>
- [17] Colucci, E., Noardo, F., Matrone, F., Spanò A., and Lingua, A. “High-level-of-detail semantic 3d gis for risk and damage representation of architectural heritage”, *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, XLII-4, pp. 107–114, 2018. DOI: <https://doi.org/10.5194/isprs-archives-XLII-4-107-2018>.
- [18] Adamopoulos E., Volinia M., Giroto M., Rinaudo F., “Three-dimensional thermal mapping from IRT images for rapid architectural heritage NDT”, *Buildings*, vol. 10, no. 10, p. 187, 2020. DOI: <https://doi.org/10.3390/buildings10100187>.
- [19] Del M.S.T.T., Tabrizi S.K., “A methodological assessment of the importance of physical values in architectural conservation using Shannon entropy method”, *Journal of Cultural Heritage*, vol. 44, pp. 135–151, 2020. DOI: <https://doi.org/10.1016/j.culher.2019.12.012>
- [20] Milošević M.R., Milošević D.M., Stanojević A.D., Stević D.M., Simjanović D.J., “Fuzzy and interval AHP approaches in sustainable management for the architectural heritage in smart cities”, *Mathematics*, vol. 9, no. 4, p. 304, 2021. DOI: <https://doi.org/10.3390/math9040304>.
- [21] Wang T., Zhao L., “Virtual Reality-Based Digital Restoration Methods and Applications for Ancient Buildings”, *Journal of Mathematics*, vol. 2022, p. 2305463, 2022. DOI: <https://doi.org/10.1155/2022/2305463>.
- [22] Spiridonov A., Umniakova N., “Problems of Restoration of Historical Fenestration for Providing the Normalized Parameters of the Microclimate of Premises in Ancient Buildings”, *IOP Conference Series: Materials Science and Engineering*, vol. 753, pp. 022064, 2020. DOI: <https://doi.org/10.1088/1757-899X/753/2/022064>
- [23] Hmood K., Jumaily H., Melnik V., “Urban architectural heritage and sustainable tourism”, *WIT Transactions on Ecology and the Environment*, vol. 227, pp. 209–220, 2018. DOI: <https://www.witpress.com/Secure/elibrary/papers/ST18/ST18020FU1.pdf>
- [24] Noardo F., “Architectural heritage semantic 3D documentation in multi-scale standard maps”, *Journal of Cultural Heritage*, vol. 32, pp. 156–165, 2018, DOI: <https://doi.org/10.1016/j.culher.2018.02.009>
- [25] Cai Z., Fang C., Zhang Q., Chen F., “Joint development of cultural heritage protection and tourism: The case of Mount Lushan cultural landscape heritage site”, *Heritage Science*, vol. 9, p. 146, 2021. DOI: <https://doi.org/10.1186/s40494-021-00613-1>
- [26] Zhao C., Zhang Y., Wang C.C., Hou M., Li A., “Recent progress in instrumental techniques for architectural heritage materials”, *Heritage Science*, vol. 7, p. 36, 2019. DOI: <https://doi.org/10.1186/s40494-019-0280-z>.
- [27] Zhang Y., Zhang H., Sun Z., “Effects of urban growth on architectural heritage: The case of Buddhist monasteries in the Qinghai-Tibet plateau”, *Sustainability*, vol. 10, no. 5, p. 1593, 2018. DOI: <https://doi.org/10.3390/su10051593>.
- [28] Shu H., Yang M., Liu Q., Luo M., “Study of TiO<sub>2</sub>-modified sol coating material in the protection of stone-architectural cultural heritage”, *Coatings*, vol. 10, no. 2, p. 179, 2020. DOI: <https://doi.org/10.3390/coatings10020179>
- [29] Yessentay D.E., Kiyalbaev A.K., Kiyalbay S.N., Borisyuk N.V., “Reliability criterion and a model for determining the optimal speed of movement on automobile roads in winter sliding conditions”, *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*, vol. 6, no. 444, pp. 119–125, 2020. DOI: <https://doi.org/10.32014/2020.2518-170X.138>