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

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Abstract

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

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

1. Introduction

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

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

1.1. Purpose

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

1.2. Problem

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

1.3. Questions

The study seeks to answer the following research questions:

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

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

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

1.4. Limitations

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

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

2. Conceptual Framework

2.1. Concept and Reasons for Adaptive Reuse

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

2.2. Choosing the Right Function and Interventions

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

2.3. Industrial Buildings and Repurposing Applications

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

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

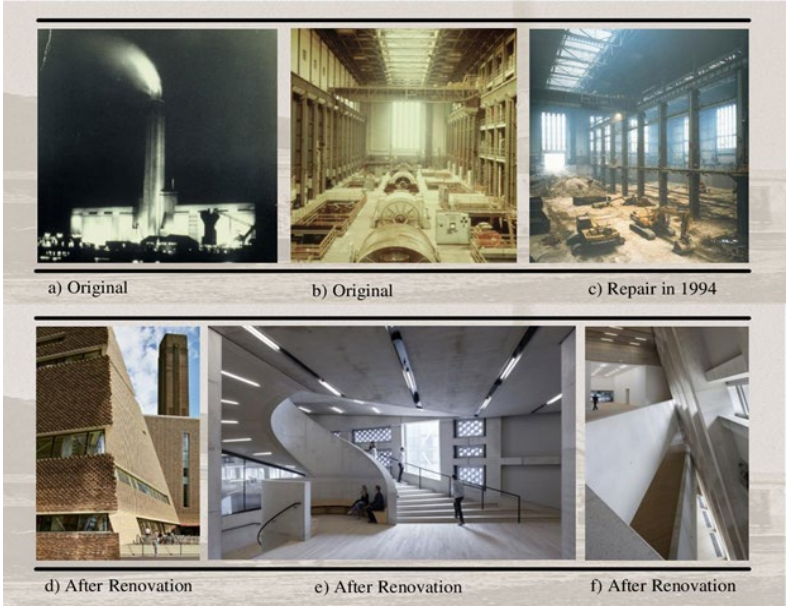

Figure 1 Tate Modern before and after its transformation (Herzog & de Meuron, n.d.)

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

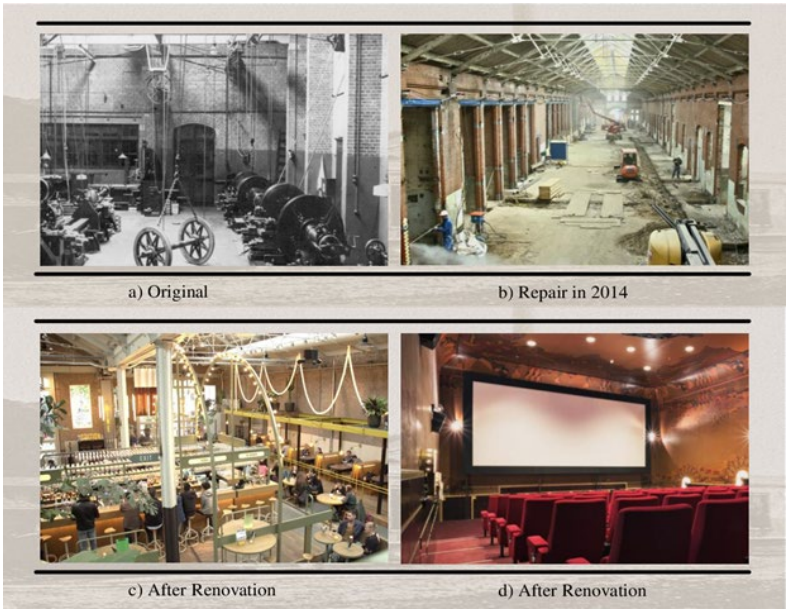

Figure 2 De Hallen interior use (De Hallen Amsterdam, n.d.)

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

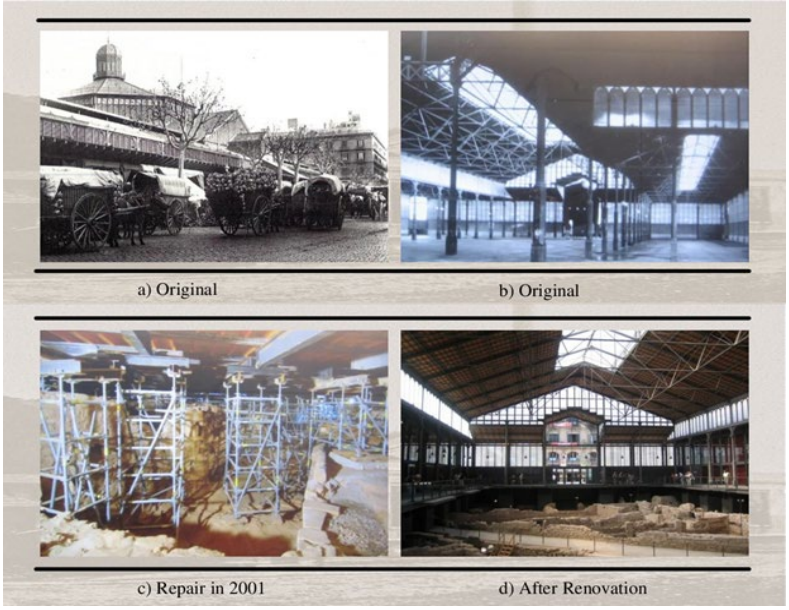

Figure 3 El Born CCM archaeological floor plan (Wikiarquitectura, n.d.)

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

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

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

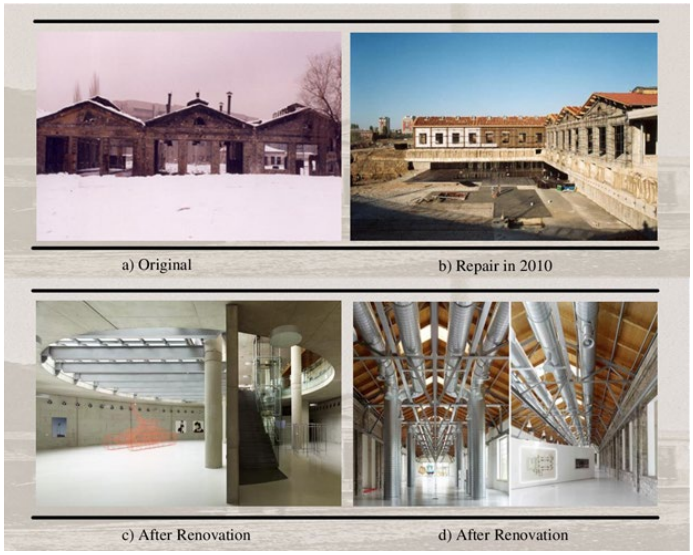

Figure 5 CerModern exhibition hall (Uygur Architects, n.d.)

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

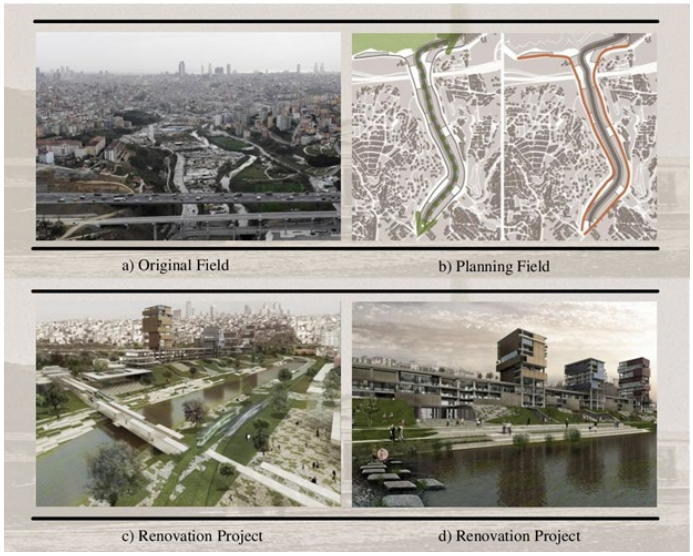

Figure 6 Cendere Art Valley master plan (Arolat, n.d.)

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

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

3. Identification of Parameters for the Adaptive Reuse Process

3.1. Theoretical Foundations of the Evaluation Parameters

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

Table 1 Academic Literature (Created by the Authors)

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

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

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

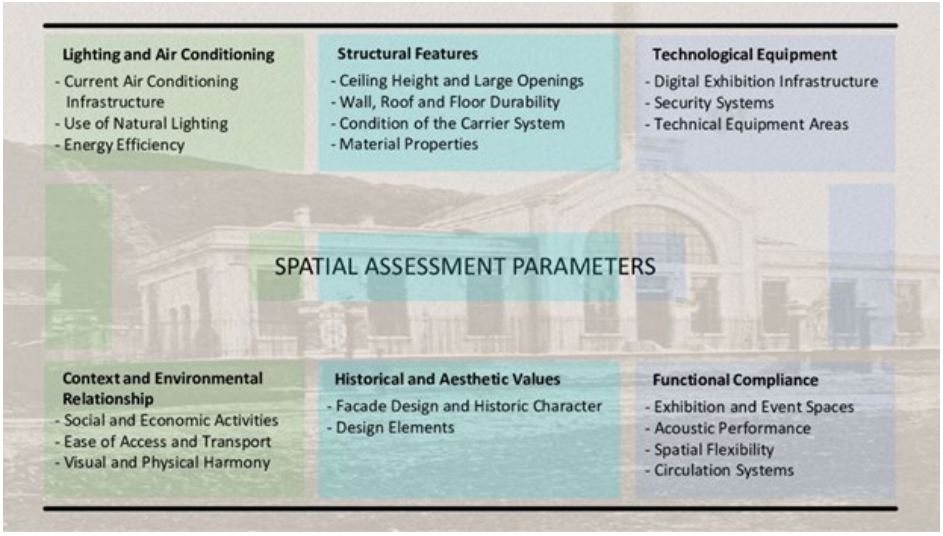

Figure 7 Cendere Art Museum, spatial assessment parameters (Created by the authors)

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

3.2. Working Area

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

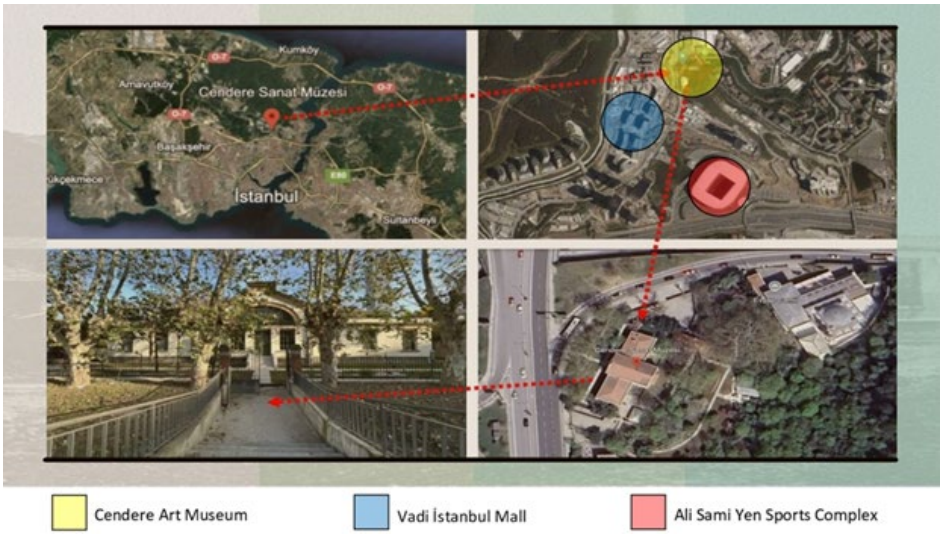

Figure 8 Environmental diagram for Cendere Art Museum (Google Earth, 2024; TKGM, 2024)

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

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

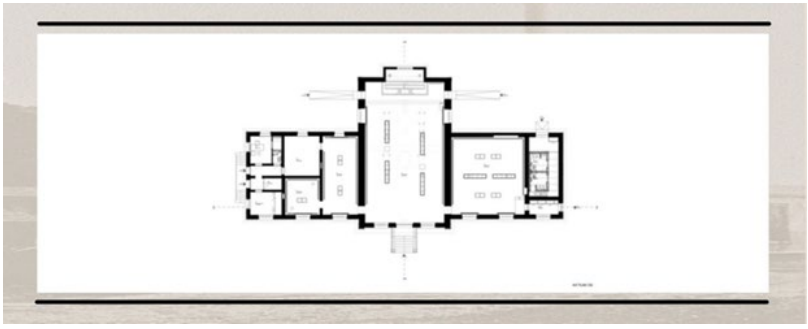

Figure 10 Ground floor plan of the Cendere Art Museum (Çınar, 2022)

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

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

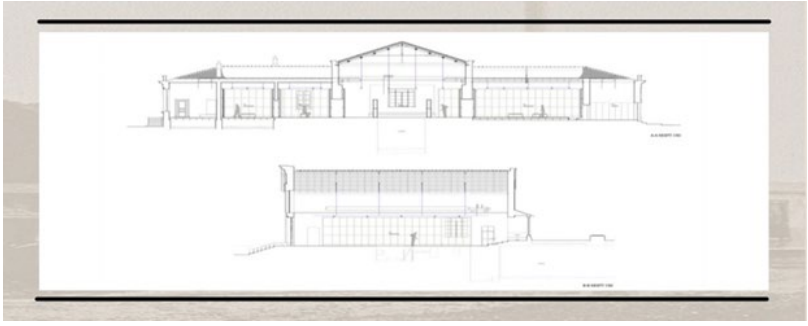

Figure 12 Sections of the Cendere Art Museum (Çınar, 2022)

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

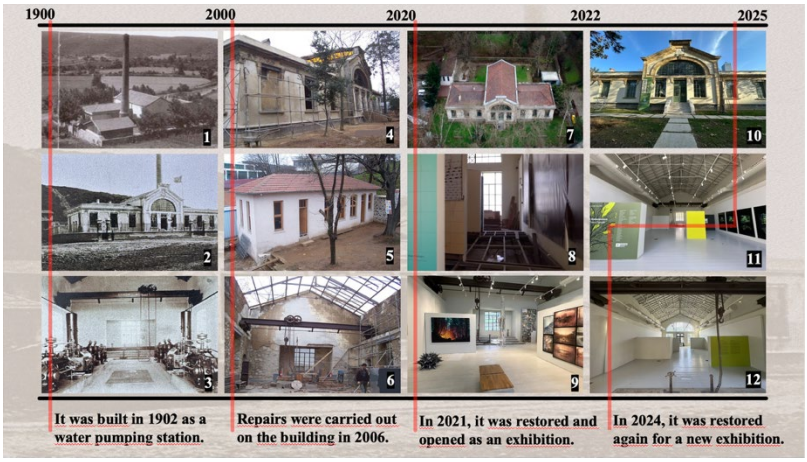

Figure 13 Historical process diagram of Cendere Art Museum (Kağıthane Municipality, n.d. [1], Cendere Art Museum, n.d. [2,3], Rena Construction, 2006 [4,5,6], Independent, n.d. [7], Youtube, 2022 [8], Artfullivingart, 2024 [9], Photographed by authors [10,11,12]. Edited by the authors)

3.3. Data Collection Tools

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

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

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

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

3.4. Analyzing the Data

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

4. Results and Discussion

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

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

4.1. Structural Features

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

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

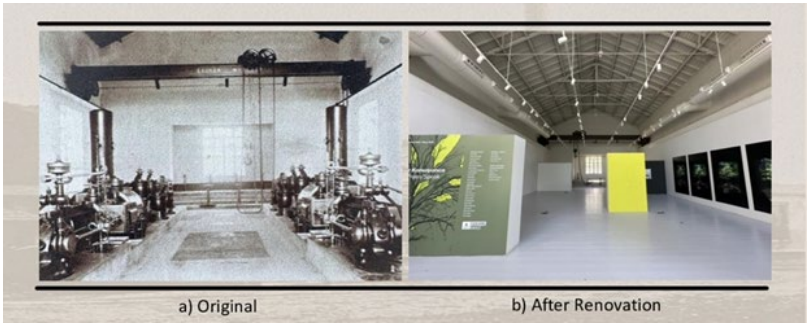

Figure 16 Cendere Art Museum ceiling and openings (Cendere Art Museum, n.d. Photographed by the authors)

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

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

4.2. Functional Compliance

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

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

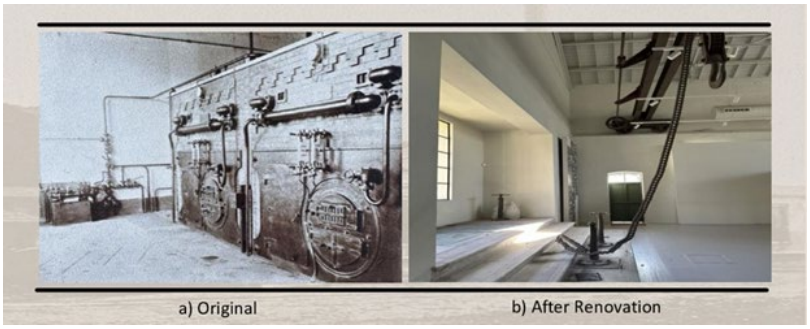

Figure 20 Cendere Art Museum circulation system (Cendere Art Museum, n.d. Photographed by the authors)

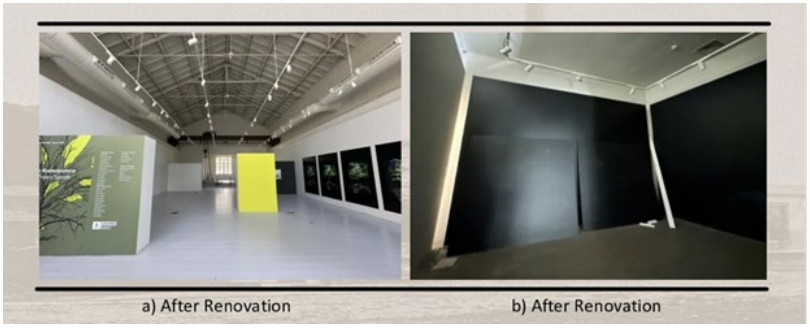

Figure 21 Cendere Art Museum exhibition and event spaces (Photographed by the authors)

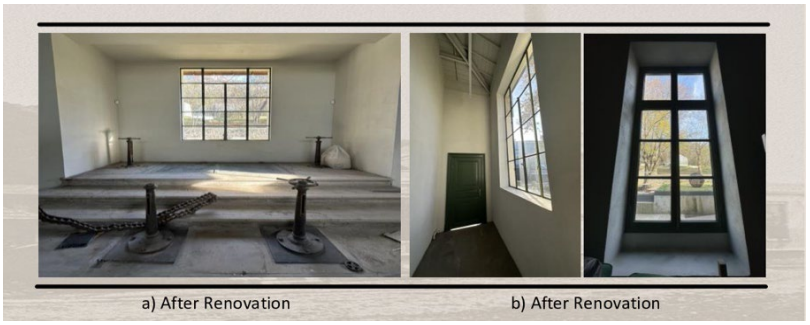

Figure 22 Openings creating acoustic problems at Cendere Art Museum (Photographed by the authors)

4.3. Lighting and Air Conditioning

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

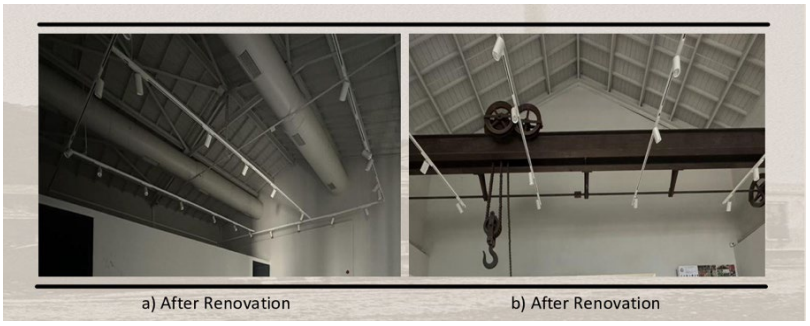

Figure 23 Cendere Art Museum lighting system (Photographed by the authors)

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

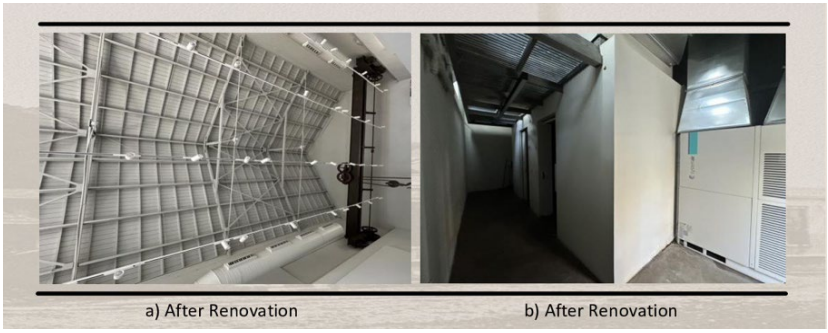

Figure 25 Cendere Art Museum air conditioning system (Photographed by the authors)

4.4. Historical and Aesthetic Values

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

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

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

4.5. Context and Environmental Integration

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

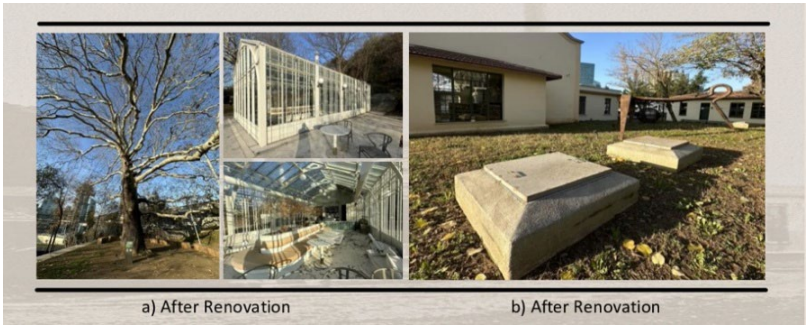

Figure 28 Cendere Art Museum landscape area renovation (Photographed by the authors)

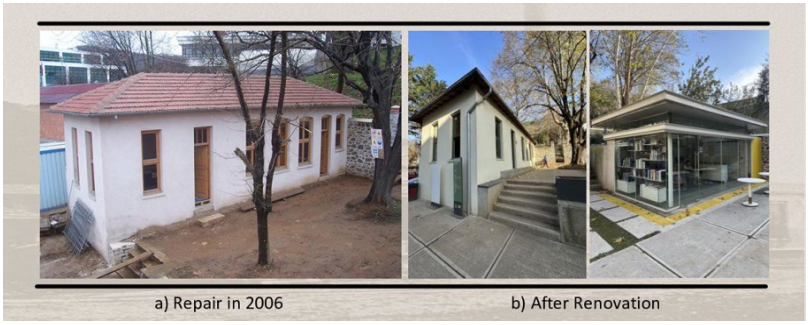

Figure 29 Cendere Art Museum administration and library buildings (Rena Construction, 2006. Photographed by authors)

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

4.6. Technological Equipment

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

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

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

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

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

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

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

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

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

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

5. Conclusion

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

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

RQ1: Impact of the Adaptive Reuse Process on Spatial Identity

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

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

RQ2: Contribution to Cultural Sustainability

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

RQ3: Transferability of the Methodological Approach to Other Projects

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

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

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

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

Suggestions for future research include:

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

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

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

Declaration of Competing Interest

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

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

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