The Implementation of Multicriteria Analysis for Heritage Assets Enhancement: An Application for the HBU Identification of a Historical Building in an Italian Municipality

Marco Locurcio[1], Felicia Di Liddo[1], Laura Tatulli[1(✉)], Pierluigi Morano[1], and Debora Anelli[2]

[1] Department of Civil, Environmental, Land, Building Engineering and Chemistry, Polytechnic University of Bari, Via Orabona 4, 70125 Bari, Italy
laura.tatulli@poliba.it

[2] Department of Architecture and Design, "Sapienza" University of Rome, Via Flaminia 359, 00196 Rome, Italy
debora.anelli@uniroma1.it

Abstract. The enhancement of properties with historical and cultural value should be consistent with the need for their preservation, the interests of stakeholders and the urge of obtaining public and/or private funding. These aspects, defined through both qualitative and quantitative criteria, can be simultaneously considered by implementing Multi-Criteria Decision Analysis (MCDA). In the present work, through the application to a case study concerning a building located in the ancient part of a municipality in Southern Italy, the potential of MCDA is tested as a support tool for evaluations related to the functional reconversion of heritage assets aimed at identifying the Highest and Best Use.

Keywords: Real estate heritage · MCDA · AHP · TOPSIS · HBU

1 Introduction

The definition of methodological approaches aimed at the efficient management of public resources represents a topic that is both highly complex and an issue of current relevance. Recent developments in decision support tools for public administration have increased interest in strategies for the optimal allocation of resources. In particular, the evaluation techniques adopted by public sector are not always able to adequately account for all the fundamental aspects involved in choices processes, specifically when these relate to the social, economic, and environmental impacts of interventions on the territory. Public assets constitute a heterogeneous patrimony belonging to a public legal entity, which manages them for the purpose of achieving specific objectives. Within these properties, attention should be paid to buildings with historical and cultural significance. In this sense, the present work focuses on real estate heritage assets, that are characterized by two aspects:

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2026
O. Gervasi et al. (Eds.): ICCSA 2025 Workshops, LNCS 15889, pp. 346–362, 2026.
https://doi.org/10.1007/978-3-031-97603-2_22

1. the purpose of ownership is primarily aimed at spreading knowledge, education or culture;
2. it is possible to circumscribe the asset, i.e. define its physical boundary.

The growing awareness of the central role of historical and artistic assets has led public administrations to seek efficient strategies for their management and use; to this end, they must implement qualitative and quantitative approaches capable of overcoming traditional ones, which are often inadequate as these are strictly focused on the financial aspects.

The proper enhancement and management of existing heritage is essential in light of their significant implications for both local and national development and economies. Indeed, these assets have a strong capacity to attract tourism flows and to provide intangible benefits to the population. Of course, the use of such assets should be compatible with conservation and protection requirements, so that they may also be used by future generations. From this perspective, it is fundamental to identify targeted intended uses that allow to benefit from both public and private funding, and, at the same time, to preserve the identity, social, cultural, and economic value of these properties [1–3].

In view of the recognized importance of cultural assets preservation and the widespread presence of numerous underutilized and/or abandoned historical and cultural buildings - often due to their degraded condition – the definition of effective strategies to ensure their conservation and valorization, is needed. The limited monetary resources of public entities represent a significant limit on these assets' requalification, and the involvement of private investors through forms of cooperation has proven to be a viable and solution. However, the integration of private funding entails the inclusion of interests and objectives that often differ from the more "passive" protection goals traditionally pursued by public bodies [4], incorporating also conflicting targets of the stakeholders.

The tendency of the public administrations towards new policies that incentivize private sector participation makes it necessary to introduce tools capable of coordinating public and private interests in the development of efficient and sustainable management interventions for heritage assets. Furthermore, in order to encourage private involvement, it is often necessary to implement functional reconversion initiatives aimed at introducing new uses that are consistent with the community needs, and possibly even different from the original ones. In this context, Multi-Criteria Decision Analysis (MCDA) represents an adequate tool for identifying the most appropriate function among different alternatives. These approaches, in fact, allow for the simultaneous consideration of different aspects that can be translated by i) quantitative criteria, among which those linked to the expectations of profitability by the private operator, and ii) qualitative ones, such as those related to compatibility with the surrounding context and with the socio-economic tissue in which the property is located.

MCDA techniques are effective for supporting investment decision-making in contexts characterized by high uncertainty [5, 6] by guarantying transparency to the entire mechanisms for the selection of "the best" project solution. In fact, they allow for: i) the reconstruction of the Decision Maker's (DM) choice process; ii) the development of a shared foundation among the various involved stakeholders; and iii) the clear and unambiguous representation of the selected option through the use of a synthetic numerical indicator and graphical outputs.

2 Aim

The several challenges associated with the heritage asset repurposing derive primarily from their peculiar specificities and the need to define interventions capable of generating positive impacts in social, economic, and environmental terms, while also ensuring the financial sustainability of the initiative [7–9] and the properties protection. To this end, appropriate tools are required to identify "the best" alternative among different potential uses, based on specific predetermined criteria [10, 11].

The reference literature includes numerous studies that explore the use of these techniques for selecting optimal solutions, i.e. to be preferred. Ribera et al. (2019), for instance, highlight how the choice of the HBU (Highest and Best Use) requires a rational approach that must be supported by appropriate tools. Among these, the study promotes the AHP (Analytic Hierarchy Process) implementation, as it allows to take into account both financial performance and the project's effects on the territory, including its ability to foster cultural development while respecting building historical and architectural characteristics [1]. Similarly, the research carried out by Nesticò et al. (2019) points out the key role of MCDAs, as these are capable of accounting for the multiple effects -financial, social, cultural, and environmental - generated by an enhancement project. In particular, the Authors develop a comparison between different multicriteria techniques, confirming the validity of AHP due to its usefulness in decomposing the problem and identifying its essential aspects [2]. In line with this framework, the work by Claver et al. (2015) examines the suitability of multicriteria techniques as part of a comprehensive methodology for analysing assets of Spanish industrial heritage, specifically as decision-support tools for assessing their potential new uses [12]. Bottero et al. (2019) propose a multicriteria decision-support approach for classifying adaptive reuse strategies for cultural heritage assets [13]. The article by Mohamed et al. (2025) aligns with this line of research, suggesting the integration of fuzzy logic with MCDA for a case study focused on the development of the built heritage in Egypt [14].

In accordance with the overview of existing scientific literature, the present work explores the role of MCDA in identifying the HBU of historically and culturally significant properties to be redeveloped. The aim of the research concerns the application of MCDA techniques to a case study relating to a functional repurposing project of a historic building located in a municipality in Southern Italy.

3 Methodological Approach

In general, MCDA approaches are structured into the following phases: i) definition of the goal; ii) construction of the criteria matrix; iii) determination of the local weights of the criteria; iv) normalization and elaboration of the alternatives matrix; v) computation of the global weights; and vi) aggregation of the weights and identification of "the best" alternative. To successfully achieve the objective, among the various existing MCDA techniques, this study adopts a combined use of the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

The AHP is based on the concept of criteria pair-wide comparing to determine their respective weights, and among alternatives for each criterion, to establish their relative

importance. The final result is obtained by aggregating the weights of criteria and the scores assigned to each alternative through the Weighted Sum Model (WSM) approach. In particular, in this study, the AHP is employed for determining the weights of the criteria (phase iii), as the presence of a consistency measure allows to verify the consistency of the pair-wise comparisons by decreasing the arbitrariness of the judgments in the weights assignment [15]. On the other hand, the fundamental idea of the TOPSIS is that "the best" solution is characterized by the minimum distance to the ideal solution and the furthest distance from the anti-ideal solution. The TOPSIS technique proves to be particularly useful in phases iv), v), and vi), as it generates four different orders depending on the type of applied normalization and the approach used to identify the ideal and anti-ideal solutions. This contributes to the robustness of the final result by making it as independent as possible from the specific adopted normalization rules, thereby overcoming one of the main limitations associated with MCDAs. The integration of these two techniques combined is a key aspect of the present analysis, as it ensures a structured and balanced approach that facilitates the decision-making process by combining a subjective approach with a rigorous analytical one. As previously described, the AHP determines the weight of each criterion based on the preferences of the DM, which reflects the individual perception as well as the social and cultural context. Complementarily, TOPSIS method uses unbiased numerical data, enabling the calculation of distances from ideal solutions and similarity coefficients through the decision matrix and data normalization process. In light of this, the application of the AHP for assigning weights to the criteria used in the TOPSIS allows the incorporation of subjective preferences and DM requirements into an objective evaluation, thereby balancing community opinions with analytical rigor in identifying the HBU. In addition, the inclusion of the Consistency Index (CI) into AHP and the data normalization in TOPSIS contribute to reduce of the subjectivity of the methods, ensuring more coherent and reliable outcomes.

This integrated approach therefore enables the DM to manage both qualitative judgment and quantitative data, providing a more efficient assessment of the alternatives. Furthermore, while the AHP facilitates the involvement of multiple DMs through the hierarchical structuring of criteria and the collection of their points of view, TOPSIS offers a clear ranking of the alternatives. Together, these techniques support participatory, transparent, and data-driven decision-making processes, enhancing acceptability, legitimacy and transparency of the final decisions.

4 The Case Study

The case study of this work concerns a building of historical and cultural significance located in the ancient part of a municipality in Southern Italy. The building first floor is currently mainly intended for a library while the largest rooms in the same floor are occasionally used for conferences and meetings. However, the local public administration (DM) recognises the current use as limited if compared to the property potentialities. In consideration of a series of funded restoration and consolidation interventions, the objective of the present analysis is to identify the HBU of the property, starting from a set of repurposing proposals suggested by the local population, professional association and representatives of local public entities.

The building was founded in 1270 as a noble residence; according to some sources, the property was originally organized *a curtis*, that is, it featured a large space enclosed by walls, with towers and *lamie* arranged at its center. Over time, several phases of transformation and expansion have occurred, each of which was driven by the urban development dynamics that encompassed different parts of the municipality historic center. Of all the transformations, the widening of the main streets of the city during the 17th century has played a major role; indeed, in 1650, with the enlargement of the street facing the main front of the building, the *a curtis* configuration was modified: the entire medieval complex was restructured together with the church. Furthermore, the entrance was set back by approximately one and a half meters. At the end of the 1600s, due to the continuous changes affecting the city's socio-economic conditions, a significant urban transformation took place: noble residences were renovated with the construction prestigious façades. After a fire that occurred at the beginning of the 18th century, the front and part of the building were rebuilt. In 1920 a partial renovation took place, more specifically, the first floor was designated as the Municipal Tax Office (Ufficio Esattoriale delle Imposte Comunali), which led to some modifications. The family residence was thus moved to the second floor, which was adapted to its new function through the addition of partition walls and independent vaulted ceilings. More recently, the deteriorated roof structures have been replaced. The portion of the façade aligned with the main entrance portal was completely rebuilt (set back by 1.5 m) in 1965, following the removal of dilapidated elements. This reconstruction was executed on behalf of the Municipal Technical Office and coincided with the donation to the municipality of the entire first floor and part of the ground floor. The building has a highly complex planimetric articulation: it is organized around three courtyards, one of which - the main one - is directly connected to the only current entrance. On the left side of this entrance there is the deconsecrated medieval chapel of Sant'Anna. The current façade is articulated into three levels: the base level, the main floor (piano nobile) and the service floor. In Fig. 1 the plan of the first floor of the case study property is reported and in Fig. 2 the main façade of the building is shown.

4.1 Building Surface Restoration and Consolidation Project

The designed restoration intervention for the building consists of a systematic set of conservation operations. In response to the observed structural and surface degradation phenomena, the project proposes technical solutions aimed at surface treatment and structural consolidation. The analysis of the ante-intervention building conditions reveals several structural damages, which are hypothesized to derive primarily from two conditions: the first is the differential settlement of the foundation segments beneath the façade of the annexed church and the main entrance portal; the second is the overturning tendency of the left-hand corner of the façade. In addition to these primary causes, successive modifications to the masonry over time has a key-role. In the light of the detected cracking patterns, different structural restoration measures have been planned, including consolidation through injections of hydraulic lime-based mortar [16, 17]. To compensate the differential settlement of the foundations, the consolidation project aims to enhance their load-bearing capacity through a series of targeted interventions. These include the insertion of carbon fiber ties (diatoni) to improve overall structural resistance;



Fig. 1. Plan of the first floor of the case study building. Floor plan based on the metric survey, for the purpose of seismic vulnerability analysis, made by Ing. Paolo Dellorusso, Studio Tecnico D'Ambrosio & Associati, Studio Pazienza-De Rienzio & Associati, Studio SIGMA srl, Architetto Antonio Maria Maffiola, Ing Saverio Catena, Ing. Francesco Glardino



Fig. 2. Main façade of the building

injections of hydraulic lime-based mortars to increase the strength of the masonry wall; and jet grouting with nanolime injections at the foundation level, intended to improve

soil compaction and load-bearing capacity. The set of cracks found on the corner portion of the building's main façade is hypothesized to be caused by the outward thrust of the corner, which tends to project into the void. The restoration project addresses this issue by inserting two steel tie rods arranged in a pseudo-orthogonal configuration, allowing the retention of the wall section that shows a tendency to overturn.

The façades of the building are characterized by various forms of surface degradation, affecting both stone and plastered elements. Among the most prevalent phenomena identified in the case study there are alveolization, efflorescence, biological patina, surface deposits, and crust formations. The restoration of the deteriorated surfaces involves a range of steps, including cleaning, consolidation, recovery, replacement, finishing, and targeted specific treatments.

Among the designed operations, the most significant ones include: the removal of incoherent surface deposits, crusts, and biological patinas and the consolidation of eroded parts and of areas characterized by material loss through reintegration using materials that are either analogous or compatible with the original ones, while remaining distinguishable through chromatic differentiation. For plastered surfaces affected by phenomena such as material loss, exfoliation, or washout, restoration regards the use of a lime-based plaster with a slightly recessed finish in relation to the original material [18].

4.2 Description of the Criteria and Identification of Their Weights

The objective of the present analysis concerns the identification of the HBU of the considered property, i.e. "the best" alternative to be preferred among the proposed project hypotheses. This goal is declined through a set of criteria that represent the various aspects to be taken into account for the HBU determination, in accordance with the logic of the DM, that is the technical office of the public administration (property owner). In particular, the technical office is composed of various professionals, such as architects, engineers, urban planners, and economic-financial consultants, who perform different functions to ensure compliance with regulations and the achievement of an adequate level of goal fulfillment across different sectors.

The involvement of different actors, in the roles of decision makers, stakeholders and users, is fundamental to guarantee a certain degree of sustainability of the repurposing project. Indeed, broad acceptance of the selected function and an adequate level of profitability contribute to reducing the risk of abandonment, vandalism, while also promoting the development of spaces with comparable uses and socio-cultural significance. Specifically, several stakeholders have been considered for this analysis and among them a key role is assigned to heritage protection and urban planning authorities, private investors, residents and involved professionals.

The criteria aim to consider, within the evaluation, the need to preserve and enhance the asset, the economic and financial aspects, the private sector level involvement, the needs of the population, and the social implications of each project alternative.

The criteria identified are:

1. Net income, defined as the difference between the total revenues and all expenses borne by the property owner for the reconversion intervention.

2. Riskiness, assessed qualitatively in terms of the likelihood of not achieving the expected net income, through a comparison of the intervention with similar ones within the same context.
3. Structural compatibility, defined on the basis of the impact of the proposed uses on the static functionality and load-bearing capacity of the building or its components.
4. Compatibility with the historical and artistic features, that is, its aptitude for conservation and protection of the property.
5. Compatibility with the surrounding context, which includes the accessibility of the building, the proximity to services and spaces with functions similar to those hypothesized for the property, and the compatibility with the land use designation of the area in which the property is located.
6. Alignment with the interests of the local population, which - given the need to maintain the public nature of the asset - assesses how the functional reconversion impacts community demand and its needs.

In Fig. 3 a summary of the evaluation criteria selected for the analysis is reported.

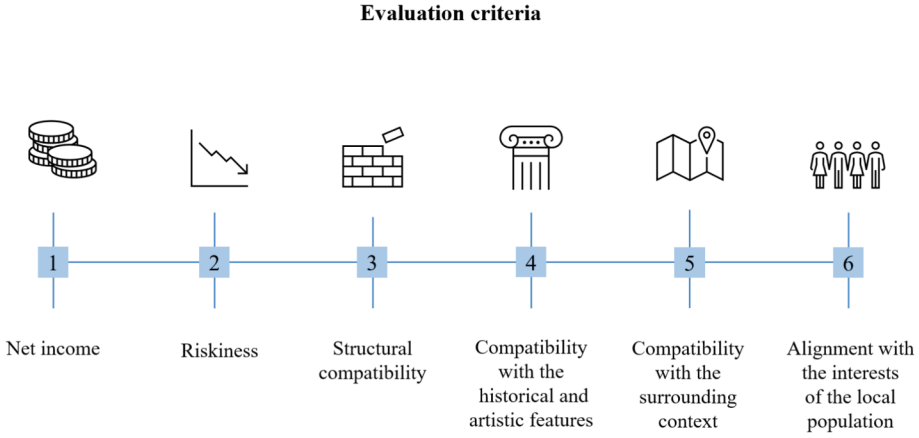

Fig. 3. Evaluation criteria used for determining the HBU

The weight of each criterion is determined starting from the opinions expressed by DM through the application of AHP, as described below. In particular, in order to gather community opinions, questionnaires are administered to the local residents, while to take professional opinions into account, consultations among experts are conducted. As a result of applying the AHP method, it is observed that the most influential criterion is the "Structural compatibility", which accounts for 39.1%. In particular, the preservation of building static functionality represents an essential requirement to ensure the long-term conservation of the asset and the proper performance of the intended uses. The adoption of alternatives that could potentially damage the load-bearing capacity may, in fact, severely compromise the maintaining of the property, as well as nullify the effects of restoration interventions. The criterion of "Compatibility with the historical and artistic features" plays a fundamental role in the decision-making process (weight of 28.5%), as

it is linked to the necessity of safeguarding these characteristics, which serve as catalysts for the cultural and identity value of the asset. Less relevant is the criterion related to the "Net income" (11.1%): although it is necessary to identify financially sustainable function, this objective remains subordinate to the overarching goals of preservation property structural and historical-artistic aspects.

"Compatibility with the surrounding context" is considered only moderately relevant (influence of 8%) compared to the previous criteria: this is due to the lower importance assigned to the alignment with the characteristics of the reference area, in relation to the structural requirements and usability of the project alternative. A similar level of priority is attributed to the criteria of "Riskiness" and "Alignment with the interests of the local population" (6.8% and 6.5%, respectively). Indeed, a low risk of intervention or a high compatibility with the community needs do not justify a functional repurposing that have a negative impact on the building structural elements or on its historic-artistic value. Moreover, the medium- and long-term sustainability perspective, that is fundamental for the heritage management, often does not align well with the immediate and current needs of the population.

The Consistency Ratio (CR), equal to 2.9%, is particularly low, indicating adherence to the transitivity principle, coherence in the expressed judgments, and, ultimately, the care with which the DM carried out the pair-wise comparisons. In Fig. 4 the different weights of the identified criteria are shown.

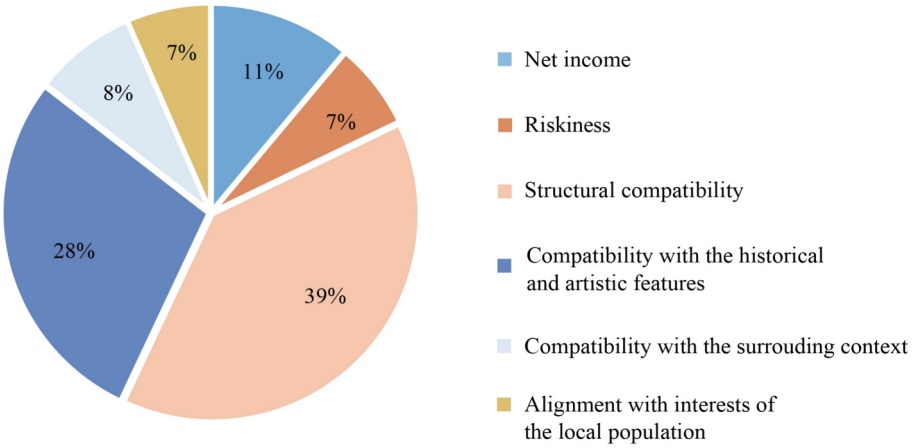

Fig. 4. Weights of the criteria

4.3 Description of the Repurposing Alternatives and Their Relative Importance

Following the described restoration and structural consolidations interventions - necessary to eliminate phenomena of degradation and to ensure proper building structural functionality - a project for the adaptive reuse of the first-floor spaces is developed. Currently, the building is only partially in use and serves as a library, study hall, and

conference room for citizens and public institutions. In the functional reconversion proposal, it is planned to use of the entire surface area (approximately 550 square meters), and five alternative options are determined:

1. Conference rooms designated to host events organized by public and private entities, subject to the payment of an hourly fee. This alternative also includes the provision of complementary services such as coffee breaks, light lunches, event promotion through social media channels, press review, event recording, and photo/video services.
2. Art exhibition spaces for temporary displays by emerging contemporary artists, subject either to the payment of a fixed fee by the event organizer or to a ticketing system for visitors, depending on the resonance. Additional services are also envisaged, such as event promotion through posters and social media channels, as well as the management of lighting and, where applicable, audiovisual elements.
3. Coworking spaces to support startups, professional firms, and companies. In particular, the proposal includes the availability of rooms of various sizes, as well as larger rooms that can be reserved for meetings and other events. The service fee includes costs for cleaning and utilities.
4. Restaurant/cafeteria. This alternative involves targeted transformation works to make the spaces compliant from both regulatory and technical standpoints, through the installation of appropriate systems and equipment. A sustainable lease agreement is proposed, consisting of a fixed component - based on the estimated total annual revenue - and a variable component linked to any potential increases in that revenue over time.
5. Non-intervention alternative, or "use as is" scenario, which entails the continuation of the current functions as a library and study hall, with the possibility of using some rooms for conferences.

Figure 5 shows the different uses of the project alternatives.

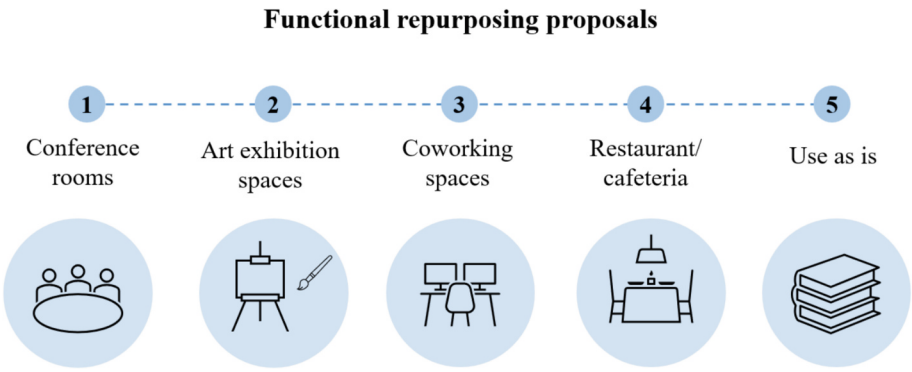

Fig. 5. Functional repurposing proposals

For each of the five alternatives a score from 0 to 10 is assigned, representing the level of satisfaction with respect to the identified six criteria. The value of 0 indicates a complete absence of satisfaction; a score of 1 corresponds to an extremely unsatisfied

criterion, 2 to very poorly satisfied, 3 to poorly satisfied, and 4 to insufficient. The score of 5 represents an averagely satisfied or acceptable criterion. A score of 6 is attributed to sufficiently satisfied criteria, 7 to more than sufficiently satisfied; 8 indicates a good level of satisfaction, 9 a very good level and 10 the maximum level of satisfaction with the criterion.

The assignment of scores within the evaluation matrix takes into account the aspects previously specified for each of the proposed design alternatives. The assessments carried out for each hypothesis of re-functionalization concerning the first-floor spaces of the building are described below.

For the conference rooms conversion option (alternative 1), the level of satisfaction with respect to the first criterion ("Net income") is considered acceptable, with a score of 5. This score is assigned by considering both the relatively low adaptation costs and the expected modest revenues, given the limited demand in the target market for conference spaces. Furthermore, this function is associated with a high level of risk ("Riskiness" criterion) due to the presence of the Diocesan Museum located in the municipality, which already includes five conference rooms with a capacity of up to 200 people, making the market nearly saturated.

With regard to the use "art exhibition spaces" (alternative 2), a score of 7 is assigned for the satisfaction of the first criterion ("Net income"). This score is given according to the presence of tourists in the city, and therefore potential of exhibition visitors. However, the costs associated with managing the lighting aspects linked to this use, are considered and covered in this score. The riskiness connected to this function is evaluated as high (with a normalized score of 2), in consideration of the presence of other buildings nearby that host permanent exhibitions, as well as additional facilities that offer their spaces for temporary exhibitions. The compliance with criteria 3 ("Structural compatibility") and 4 ("Compatibility with the historical and artistic features") for the proposed use is high, with scores of 9 and 8 respectively. Indeed, no significant structural modifications are foreseen that would affect the building's stability or compromise its historical and artistic value. The "Compatibility with the surrounding context" is likewise high (score of 10), given the presence of similar activities and services aligned with the tourist flows attracted by the exhibition function. Similarly, this intended use is assumed to be well-received by the local population, as it allows to maintain the access to the spaces and their use for activities recognized as culturally valuable.

The conversion of the building's spaces into coworking areas (alternative 3) is evaluated as moderately consistent with criterion 1 ("Net income"). In fact, although the implementation of this option does not require high adaptation costs, significant revenues are not expected. Consistent with this, the intervention's riskiness level (criterion 2) is considered relatively high (normalized score of 3), due to the presence of other coworking spaces in the same area, which are presumed to absorb nearly the entire market demand. No impactful transformations are provided for in terms of structural aspects or the building's historical and artistic features; therefore, the satisfaction of criteria 3 and 4 is evaluated as optimal, with a score of 10. The compatibility with the surrounding context (criterion 5) is considered more than sufficient (score of 7), as - despite the building's limited accessibility by private vehicles or public transportation - this type of activity is consistent with the uses in the surrounding area. The level of

public appreciation (criterion 6) is assumed to be insufficient (score of 4), given that this function would effectively privatize the use of the building.

For the implementation of a restaurant or a cafeteria (alternative 4), the expected net income (criterion 1) is assessed as sufficient (score of 6), and the riskiness (criterion 2) associated with the conversion is evaluated with a normalized score of 4. These assessments are based on the significant expenses required for the transformation project, compared to the relatively modest expected revenues. Additionally, the presence of similar uses in the surrounding area is taken into account, although these have lower attractive potential as the analysed building is characterized by a high historical and artistic value. "Structural compatibility" levels are lower than those of the other alternatives (score of 7), as moderate structural impacts are planned. "Compatibility with the historical and artistic features" (criterion 4) is assessed as low (score of 5), since the designed modifications, the expected number of users, and exposure to fumes from typical restaurant activities may have negative effects on valuable architectural elements. For criterion 5 ("Compatibility with the surrounding context"), the maximum score is assigned, in light of the strong alignment with existing activities in the area. Similarly, the "Alignment with the interests of the local population" (criterion 6) is highly rated, as this option allows to maintain public access without privatizing the spaces.

With reference to the alternative "use as is" (alternative 5), that provides the absence of functional reconversion interventions and, thus, the current library intended use, a low score is assigned for expected "Net income" (score of 3). Indeed, while no transformation costs are involved, the building in its current state does not generate any revenue. Furthermore, this function is associated with a moderate riskiness (criterion 2), given the absence of other libraries within the territory. The "Structural compatibility", the "Compatibility the with the historical and artistic features" and "the surrounding context" (criteria 3, 4 and 5), are assessed as optimal, due to the lack of modifications or interventions that could impact the building's static or architectural integrity. In addition, a limited flow of users is assumed, along with the absence of activities that could potentially damage the valuable decorative elements. Moreover, the use of the building as a municipal library appears well-suited to the surrounding context and it is positively received by the local population (criterion 6), also thanks to a perception that has become well-established over time as public space.

The evaluation matrix of the criteria and alternatives is elaborated in the following Table 1.

4.4 Identification of the HBU

To identify the HBU, the determination of the synthetic numerical indicator, that is the TOPSIS closeness coefficient, is carried out. In particular, the coefficients obtained for each of the four different orders - depending on the type of applied normalization and the approach used to identify the ideal and anti-ideal solutions - point out that in three out of four cases, the HBU corresponds to the "coworking spaces" alternative (alternative 3). Only in one case the project solution to be preferred is the current intended use (alternative 5, i.e. "use as is"). In all scenarios, the "restaurant/cafeteria" option (alternative 4) ranks as the least favorable. The "coworking spaces" solution is highly compatible with structural and historical-architectural aspects (criteria 3 and 4), which

Table 1. Criteria and alternatives evaluation matrix

	j	1	2	3	4	5	6
		Net income	**Riskiness**	**Structural compatibility**	**Compatibility with the historical and artistic features**	**Compatibility with the surrounding context**	**Alignment with interests of the local population**
i	***Weight***	11%	7%	39%	28%	8%	7%
1	**Conference rooms**	4	2	10	10	6	4
2	**Art exhibition spaces**	7	2	9	8	10	10
3	**Coworking spaces**	5	3	10	10	7	4
4	**Restaurant/ cafeteria**	6	4	7	5	10	8
5	**Use as is**	3	5	10	10	9	9

are the most important (with respective weights of 39% and 28%) for achieving the set goal. In contrast, although the "restaurant/cafeteria" alternative aligns well with the context and community interest (criteria 5 and 6), it entails moderately impactful transformations on structural aspects and potential damages to historically and artistically valuable elements.

The adaptive reuse of the building as "art exhibition spaces" (alternative 2) is, in all four cases, considered a more favorable option than the creation of a restaurant/cafeteria, yet less preferable compared to the other three alternatives. This is due to the need to install systems and facilities to support exhibitions, which have an impact - although less severe than that caused by converting the spaces for restorative use - on structural elements and artistic features (i.e., criteria 3 and 4, which are the most influential). The maintenance of the current function (alternative 5) and the conversion into conference rooms (alternative 1) are evaluated as nearly equally valid solutions in two of the four orders, and similarly acceptable in the remaining cases. This outcome reflects analogous levels of compatibility with the criteria 3 and 4 (the most influential), and only moderately different values for the criteria related to compatibility with the context and population interests (criteria 5 and 6 that are less influential compared to the others), for which the non-transformation scenario is slightly more favorable. In Fig. 6 the orders obtained by the TOPSIS technique implementation are reported.

As previously mentioned, the selection of the HBU does not represent the identification of the best alternative in absolute terms, but rather a form of compromise that balances to the satisfaction of different selected criteria. In fact, the functional conversion of a historical building into coworking spaces presents certain limitations. In this sense, the expected net income may not adequately meet economic expectations and needs, especially when considering the associated risk levels of the intervention.

5 Results Analysis

The combination of the AHP and TOPSIS techniques offers a structured and balanced decision-making approach by integrating subjective judgments evaluated in the AHP with objective analysis carried on in the TOPSIS method. In particular, the AHP assign

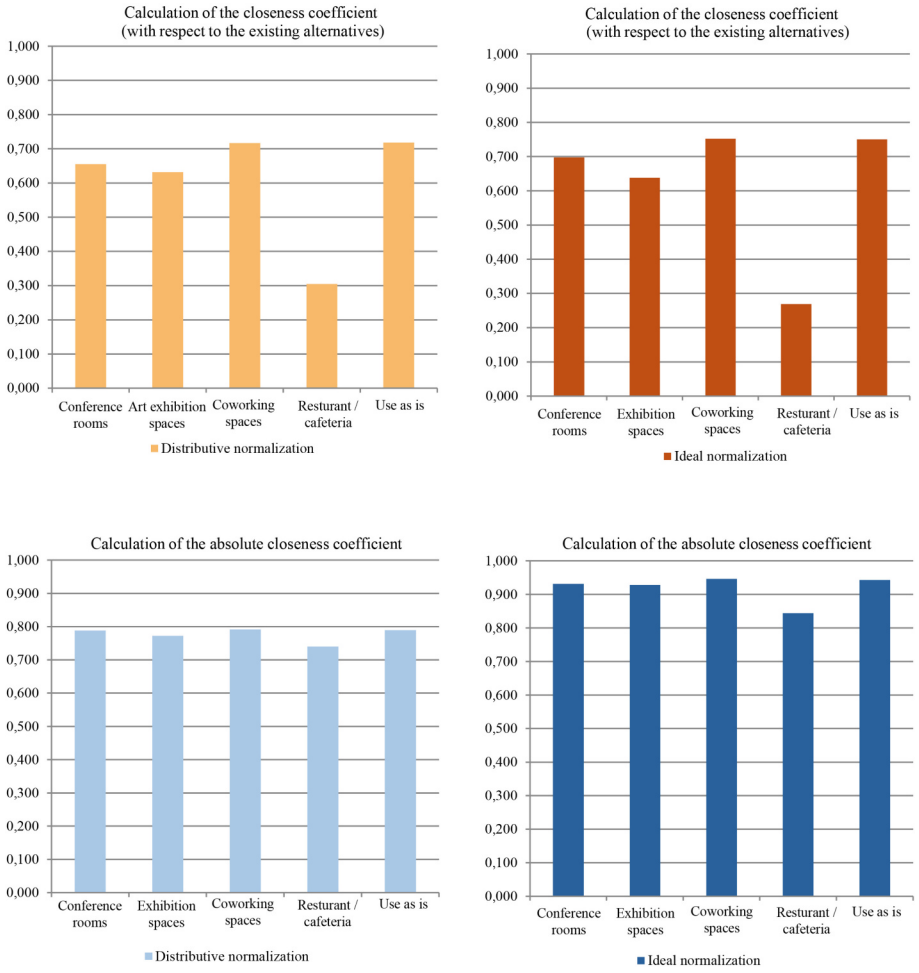

Fig. 6. Orders obtained by the TOPSIS technique implementation

criterion weights based on the decision maker's preferences, while TOPSIS uses normalized numerical and unbiased data to rank alternatives. The implementation of these two approaches, therefore, enhances the consistency and reliability of results integrating the DM preferences in a rigorous evaluation. Moreover, the AHP facilitates stakeholder participation, while TOPSIS ensures transparency through clear rankings. Together, they support participatory and data-driven decisions.

Despite these strengths, it is important to acknowledge some limitations. The main one, typical of the multicriterial approaches, derives from the subjectivity of the judgements expressed by the DM. Although this is partially overcome by i) the involvement of several stakeholders, ii) the use of the CI and iii) the normalization of the data typical of the TOPSIS method, subjectivity still remains an intrinsic aspect of these approaches.

Furthermore, through a correlation analysis (Table 2), a strong positive correlation has been identified between the criterion of compatibility with the historical and artistic features and that of structural compatibility, as well as between the criteria of compatibility with the surrounding context and alignment with interests of local population. These correlations suggest that certain criteria may provide information that are not sufficiently independent.

Table 2. Correlation matrix

	Net income	Riskiness	Structural compatibility	Compatibility with the historical and artistic features	Compatibility with surrounding context	Alignment with interests of the local population
Net income	1,00	-0,49	-0,61	-0,65	0,52	0,34
Riskiness		1,00	-0,18	-0,14	0,38	0,34
Structural compatibility			1,00	1,00	-0,68	-0,41
Compatibility with the historical and artistic features				1,00	-0,70	-0,44
Compatibility with surrounding context					1,00	0,92
Alignment with interests of the local population						1,00

6 Conclusions and Future Insights

The enhancement of underutilized real estate assets - particularly those with historical and architectural significance - represents an important opportunity to revitalize buildings and urban areas from both a social and economic perspective [19–22]. However, the scarcity of resources available to public administrations, which are often the owners of such properties, the constraints to ensure the heritage protection and the lack of interest from private investors - discouraged by restrictions on potential uses - make it challenging to define new functions that can give new life to these properties.

MCDA techniques allow to overcome these obstacles by establishing a shared platform among the various stakeholders involved in the valorisation process. In this research, through a case study focused on identifying the optimal use for a historic building located in a municipality in Southern Italy, the application of these tools in decision-making processes has been tested. Specifically, the implementation of two different multicriteria approaches (AHP and TOPSIS) has enabled to carry out a clear and transparent identification of the HBU by the DM, while reducing the uncertainty typically associated with such procedures and the resulting difficulties.

As described before, the combination of these two techniques in the present work has some limitations; indeed, while the consistency index and data normalization contribute into reducing subjectivity, the intrinsic subjectivity of multicriteria approaches, which may introduce bias, is still present. In addition to this critical issue the correlation matrix in Table 2 identifies a strong positive correlation between some of the criteria

suggesting that provided information are not sufficiently independent. In the light of these considerations, future developments of this approach applied to the specific case study may include the quantitative definition of certain criteria, such as net income and investment riskiness (the latter being analysable through the study of volatility in similar investments). In fact, the inclusion of less subjective criteria and of indicators already used in academic works with similar purposes could contribute to a more robust and efficient evaluation based on accurate and reproducible calculation. Furthermore, through a more refined differentiation, reformulation, merging, or restructuring of these criteria the reduction of redundancy and improvement of the consistency of the DM choices could be obtained.

Note: The current study has been developed within the current research P.R.I.N. Project 2022: "INSPIRE—Improving Nature-Smart Policies through Innovative Resilient Evaluations", Grant number: 2022J7RWNF.

References

1. Ribera, F., Nesticò, P., Cucco, P., Maselli, G.: A multicriteria approach to identify the Highest and Best Use for historical buildings. J. Cult. Herit. **41**, 166–177 (2020)
2. Nesticò, A., Somma, P.: Comparative analysis of multi-criteria methods for the enhancement of historical buildings. Sustainability **11**(17), 4526 (2019)
3. Mısırlısoy, D., Günçe, K.: Adaptive reuse strategies for heritage buildings: a holistic approach. Sustain. Cities Soc. **26**, 91–98 (2016)
4. Locurcio, M., Morano, P., Tajani, F.: Un modello di supporto alle decisioni per la riconversione funzionale di immobili pubblici dismessi. LaborEst **13**, 28–33 (2016)
5. Chen, O., Han, D.: A participatory multiple criteria decision analysis to tackle a complex environmental problem involving cultural water heritage and nature. Water **10**(12), 1785 (2018)
6. Ferretti, V., Bottero, M., Mondini, G.: Decision making and cultural heritage: An application of the Multi-Attribute Value Theory for the reuse of historical buildings. J. Cult. Herit. **15**(6), 644–655 (2014)
7. Wang, H.J., Zeng, Z.T.: A multi-objective decision-making process for reuse selection of historic buildings. Expert Syst. Appl. **37**(2), 1241–1249 (2010)
8. Maselli, G., Cucco, P., Nesticò, A., Ribera, F.: Historical heritage–MultiCriteria Decision Method (H-MCDM) to prioritize intervention strategies for the adaptive reuse of valuable architectural assets. MethodsX **12**, 102487 (2024)
9. Cao, Z., Huang, L., Mao, Y., Mustafa, M., Isa, M.H.M.: Navigating complexity in sustainable conservation: a multi-criteria decision making of architectural heritage in urbanizing China. J. Build. Eng. 111906 (2025)
10. Della Spina, L.: Adaptive sustainable reuse for cultural heritage: a multiple criteria decision aiding approach supporting urban development processes. Sustainability **12**(4), 1363 (2020)
11. Pavlovskis, M., Migilinskas, D., Antucheviciene, J., Kutut, V.: Ranking of heritage building conversion alternatives by applying BIM and MCDM: a case of Sapieha Palace in Vilnius. Symmetry **11**(8), 973 (2019)
12. Claver, J., Sebastián, M.A., Sanz-Lobera, A.: Opportunities of the multicriteria methods in the study of immovable assets of the Spanish industrial heritage. Procedia Eng. **132**, 175–182 (2015)

13. Bottero, M., D'Alpaos, C., Oppio, A.: Ranking of adaptive reuse strategies for abandoned industrial heritage in vulnerable contexts: a multiple criteria decision aiding approach. Sustainability **11**(3), 785 (2019)
14. Mohamed, B., Marzouk, M.: Post-adaptive reuse evaluation of heritage buildings using multi-criteria decision-making techniques. J. Build. Eng. **99**, 111485 (2025)
15. Morano, P., Locurcio, M., Tajani, F.: Cultural heritage valorization: an application of AHP for the choice of the highest and best use. Procedia Soc. Behav. Sci. **223**, 952–959 (2016)
16. Carbonara, G.: Trattato di restauro architettonico. Terzo Aggiornamento. Grandi temi di restauro (2008)
17. Franceschi, S., Germani, L., Cruciani Fabozzi, G. Manuale operativo per il restauro architettonico. In: Manuale operativo per il restauro architettonico (2007)
18. Lazzarini, L., Laurenzi, T. M. Il restauro della pietra (2009)
19. Tajani, F., Morano, P., Di Liddo, F.: The optimal combinations of the eligible functions in multiple property assets enhancement. Land Use Policy **99**, 105050 (2020)
20. Morano, P., Tajani, F., Di Liddo, F., Amoruso, P.: The public role for the effectiveness of the territorial enhancement initiatives: a case study on the redevelopment of a building in disuse in an Italian small town. Buildings **11**(3), 87 (2021)
21. Tajani, F., Morano, P., Di Liddo, F., Locurcio, M.: An innovative interpretation of the DCFA evaluation criteria in the public-private partnership for the enhancement of the public property assets. In: New Metropolitan Perspectives: Local Knowledge and Innovation Dynamics Towards Territory Attractiveness Through the Implementation of Horizon/E2020/Agenda2030–Volume 1, pp. 305–313. Springer International Publishing (2019)
22. Tajani, F., Morano, P.: Concession and lease or sale? A model for the enhancement of public properties in disuse or underutilized. WSEAS Trans. Bus. Econ. **17**, 18 (2014)