sustainability

MDPI

Article

Comparative Analysis of Multi-Criteria Methods for the Enhancement of Historical Buildings

Antonio Nesticò * and Piera Somma

Department of Civil Engineering, University of Salerno, 84084 Fisciano (SA), Italy
* Correspondence: anestico@unisa.it; Tel.: +39-089-964318

Received: 26 July 2019; Accepted: 18 August 2019; Published: 21 August 2019

Abstract: The protection of cultural heritage is essential to preserve the memory of the territory and its communities, but its enhancement is also important. In this perspective, the theme of choosing the best use for historic buildings, which often make up a substantial and widespread part of real estate and which can become a driving force for the sustainable development of cities, is important. These decision-making processes find effective support tools in Multi-Criteria Decision Making (MCDM) methods, able to consider the multiple financial, social, cultural, and environmental effects that the enhancement project generates. In order to identify the most appropriate evaluation approach to select the best use of the building, this paper proposes a comparison between some of the best-known MCDM methods: Analitic Hierarchy Process (AHP), ELimination Et Choix Traduisant la REalité (ELECTRE), Tecnique for Order Preference by Similarity to Ideal Solution (TOPSIS), and the Compromise Ranking Method (VIKOR). The comparative analysis gives rise to the validity of the AHP, which is useful for reducing the problem into its essential components, so as to make a rational comparison among the design alternatives based on different criteria. The novelty of the research is the characterization of the hierarchical structure of the model, as well as the selection of criteria and indicators of economic evaluation. The application of the model to a real case of recovery and enhancement of a former convent in the province of Salerno (Italy) verifies the effectiveness of the tool and its adaptability to the specificities of the case study.

Keywords: economic evaluation of projects; Multi Criteria Decision Making (MCDM); historical building; economic enhancement

1. Introduction

In recent decades, growing interest in historic buildings has grown in the European context. In fact, these possess a cultural, social, and economic value capable of generating virtuous processes for the development of the surrounding territory [1,2]. In preserving this heritage, to interrupt the frequent degradation processes and promote recovery activities, it is necessary to give legal force to the actions necessary for its protection, as the historical environment is vulnerable [3].

However, it is important to highlight that just protection of the historic building alone does not guarantee the economic development of the surrounding communities, and does not always have a positive impact on their quality of life. Indeed, citizens often do not have the opportunity to access or use the historic building. It is therefore necessary to guarantee public space and accessibility, and more generally, the inclusion of architectural heritage in management and development programs aimed at meeting the needs of residents [4,5].

The recovery and enhancement of the historic building can be important for the sustainable development of the city [6,7]. From this point of view, it is sufficient to think about the saving of soil that is generated where derelict buildings are recovered and reused [8]. The indication of the right function provides the decision-maker with indispensable data to evaluate the correctness of the intervention, the integration with the context, the respect of the building, and investment opportunities. In the process of recovery and enhancement of the real estate property, the identification of the best use maximizes the effects of the project, not only in purely financial terms, but also in social, cultural, and environmental terms [9–11].

On the one hand, the functional destination must satisfy the existing technical-urban planning constraints, which usually put significant limits on the possible alternatives; on the other hand, it must look at the financial sustainability of the investment project, and at maximizing the benefits for the community [12,13].

But what approaches are possible to establish the optimal destination with regard to the multiple needs of a community? The economic evaluation of the projects provides multi-criteria methodologies for analysis. A peculiarity of these methodologies is precisely the ability to consider the multi-dimensional character of the evaluation problem, allowing a comparative analysis of the alternatives according to multiple criteria, both quantitative and qualitative [14,15].

The recovery, protection, and valorization of historic buildings represent a demanding, yet unavoidable bet, where careful actions on the vast existing heritage can certainly contribute to the relaunch of the building sector and to the achievement of all the benefits of urban regeneration [16–18].

2. Aim of the Paper

The research mainly pursued three goals. Starting from a comparative evaluation of different methods of multicriterial analysis, the objective was to identify an effective approach to establish the best use of a historic building, despite the multiple technical-urbanistic and financial constraints that characterize any option of investment.

The second objective was to select multiple social, cultural, and financial criteria that would be useful for logically structuring the economic analysis model. This is fundamental to reconcile the multiple evaluative aspects involved and to rationally organize the available information.

The third objective was the characterization of a model based on the Analytic Hierarchy Process (AHP) algorithms able to compare functional alternatives based on different selected criteria, so as to choose the optimal use for the historic building.

The resolution of a real multicriterial evaluation problem concerning the recovery and enhancement of a former convent in the province of Salerno (Italy) allows for the verification of both the usefulness of the proposed model and its easy adaptability to the specificities of the case study.

3. MCDM Methods Comparative Analysis

With reference to urban and territorial planning interventions and the building heritage, the multi-criteria analysis methods allow for comparisons of different design solutions on the basis of multiple criteria (financial, social, cultural, and environmental), which can be expressed through quantitative or qualitative indicators [19]. Thus, unlike the cost–benefit analysis that expresses the judgment of economic convenience only on the monetary criterion, the multicriteria analysis rationalizes the selection process through the optimization of a multi-criteria vector, weighted according to the decision-maker's priorities. In this way, it is possible to include both monetizable and extra-economic criteria, measurable only in physical or qualitative terms, in a single evaluation process [20,21].

Through logical-mathematical algorithms structured on parameters specific to the technical, economic, managerial, social, environmental, and psychological disciplines, the methods of multicriterial analysis allow for the ordering of the possible solutions to the problem, even when there is no alternative that clearly prevails over the others—in other words, one that is capable of simultaneously maximizing all the evaluation criteria [22]. These methods make it possible to identify the optimal solution that can better combine the set of objectives [23].

The literature offers a wide range of techniques, such as: the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), ELimination Et Choix Traduisant la REalité (ELECTRE), Preference Ranking Organization METHods for Enrichment Evaluations (PROMETHEE), Tecnique for Order

Preference by Similarità to Ideal Solution (TOPSIS), Compromise Rankimg Method (VIKOR), and EVAluation of MIXed criteria (EVAMIX). Use of the AHP, ELECTRE, TOPSIS, and VIKOR methods are certainly widespread, and these are the subject of this research [24–35].

In general, the choice of the most appropriate multi-criteria method to solve the evaluation problem depends on the characteristics of the case study, in terms of the objectives of the analysis, reference territory, and specificity of the intervention, nature, and quality of the information available to the analyst [36,37].

The AHP method is more effective in the presence of the criteria and sub-criteria of evaluation, since through a hierarchical structure, at several levels, it allows the complex problem to be broken down into simpler sub-problems that can be analyzed in greater detail. The other three methods only consider criteria and do not include the presence of sub-criteria.

The hierarchical structure of the AHP has: the main goal of the decision-maker at the top; the sub-goals at the underlying level; and the criteria that lead to the achievement of sub-goals at an even lower level [30,33]. The criteria can be expressed by sub-criteria up to the most appropriate breakdown level for full understanding of the problem. The last level is that of alternatives [29,32,33,38].

The hierarchical analysis requires the estimation of the weights w to be associated with each criterion and the various alternatives. This estimate is carried out using evaluation matrices whose individual elements, a_{ij}, are obtained by comparing the criteria and the alternatives with reference to each criterion.

The A matrices of pairwise comparisons are of the type:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix} \tag{1}$$

These matrices are:

- Positive—that is, all the principal minors are positive, where by 'principal minor', we mean the determinant of the square sub-matrix formed by the first n rows and m columns (with $1 \leq m \leq n$);
- Reciprocal, being $a_{ij} = 1/a_{ji}$ and therefore, the elements on the main diagonal are all unitary ($a_{ii} = 1$). This relationship of reciprocity arises from the need to guarantee the symmetry of judgments of importance;
- Constituted by finite elements, since for each criterion, C, considered, we have $a_{ij} \neq \infty$.

As suggested by Saaty, comparisons can be made according to the semantic scale with scores 1, 3, 5, 7, and 9 [33].

Commonly, in real cases, the relationship w_i/w_j is not known, so it is necessary to look for a_{ij}, such that $a_{ij} \approx w_i/w_j$. If W is the matrix of the weights and w the column vector of the sought variables, then:

$$W \cdot w = n \cdot w \tag{2}$$

In extended form:

$$W \cdot w = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = \begin{bmatrix} n\, w_1 \\ n\, w_2 \\ \vdots \\ n\, w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = n \cdot w \tag{3}$$

Therefore, the matrix W has, as its sole eigenvalue, its order n, and as a corresponding eigenvector, the vector of the sought variables. This means that it is possible to obtain the values of the variables w_1, w_2, ..., w_n, starting from the relationships between them, taken two at a time. This allows us to affirm that, if we do not have the exact value of the relations w_i/w_j ($i, j = 1, 2, \ldots, n$), but their estimate, the method of the eigenvalue can still be usefully used for the approximate evaluation of the variables. The values thus obtained are closer to the exact ones if the estimates of the w_i/w_j ratios are consistent between them [39]. In this case, all the n eigenvalues are almost zero, and if the ratios are coherently estimated, the maximum eigenvalue λ_{max} is not far from the value n, which can therefore be assumed as an approximate estimate of the vector w:

$$W \cdot n = \lambda_{max} \cdot w \quad con \quad \lambda_{max} \geq n \tag{4}$$

Alternatively, the vector w can be determined by normalizing the matrix W through the ratio of each of its elements to the sum of the elements placed in the same column. The arithmetic mean of each of its lines is then calculated [40].

The consistency measure of the values assigned to the w_i/w_j ratios derives from the difference between λ_{max} and n. This difference is null for perfectly consistent estimates. The relationship consistency index CI is defined as:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{5}$$

The CI index must be compared to the RCI random consistency index, whose value is a function of the number n of variables according to Table 1.

Table 1. RCI values.

n	1	2	3	4	5	6	7	8	9
RCI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

The relationship between CI and RCI is defined as the Consistency Ratio (CR):

$$CR = \frac{CI}{RCI} \tag{6}$$

Binary comparisons are sufficiently coherent with one another if:

- CR < 5% for $n = 3$;
- CR < 9% for $n = 4$;
- CR < 10% for $n > 4$.

The final step is to calculate the overall weights (or priorities) of the actions. For this, it applies the principle of hierarchical composition, by virtue of which the local weights of each element are multiplied by those of the corresponding superordinate elements. Finally, the products obtained are added together [30].

Compared to AHP, the ELECTRE method is not preferred when there is a large number of alternatives and a large number of criteria. Depending on the number of alternatives, the values of the concordance threshold $\underline{c}$ and the discordance threshold $\underline{d}$ are calculated. On the basis of these values, we constructed the dominance matrix of concordance F, whose elements f_{kp} are:

$$f_{kp} = 1 \text{ if } c_{kp} \geq \underline{c} \quad f_{kp} = 0 \text{ if } c_{kp} < \underline{c}$$

and the dominance matrix of discordance G, whose g_{kp} elements are:

$$g_{kp} = 1 \text{ if } d_{kp} \geq \underline{d} \quad g_{kp} = 0 \text{ if } d_{kp} < \underline{d}$$

where c_{kp} represents the set of all the criteria for which the alternative A_k is preferable to the alternative A_p, and d_{kp} is the complement of c_{kp}. The product of the homologous elements of the matrices F and G returns the aggregate dominance matrix, E:

$$E = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1p} \\ e_{21} & e_{22} & \cdots & e_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ e_{k1} & e_{k2} & \cdots & e_{kp} \end{bmatrix} \tag{7}$$

which allows the construction of a partial ordering of the alternatives, since the columns in which the value 1 appears indicate the alternatives to be discarded because they are dominated by the others. Therefore, ELECTRE, unlike the other models in question, does not provide a final ranking of scores, but only an order of preference. Precisely, the peculiarities of the calculation algorithms can make ELECTRE easier to use if the number of evaluation criteria is particularly limited.

Despite being very versatile, as it can be applied even in the presence of a large number of criteria and alternatives, the TOPSIS method tends to reject those alternatives that have low values in most of the attributes. Specifically, for each criterion, TOPSIS searches for the ideal solution, A^* and the ideal negative solution, A^- (respectively better and worse performance offered by the alternatives considered), with respect to which it calculates the distances S_i^* and S_i^-. It is possible to determine the relative distance C_i^* of the generic alternative A_i, with respect to the ideal solution:

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \tag{8}$$

For the final classification, the best solution is the one that presents the minimum distance from A^* and the maximum distance from A^- at the same time—that is, the one with the highest value of C_i^*.

The VIKOR method substantially has the same characteristics of TOPSIS, but unlike the latter, does not provide for the presence of an ideal negative solution. In fact, VIKOR considers the optimal alternative to be the one closest to the ideal solution. The lowest value of the Q_i scalar corresponds to this alternative:

$$Q_i = \nu \frac{S_i - S^*}{S^- - S^*} + (1 - \nu) \frac{R_i - R^*}{R^- - R^*} \tag{9}$$

In (9), the variable ν is between 0 and 1, and allows to give different weight to the single addends. Moreover:

$$S_i = \sum_{j=1}^{m} \frac{w_j\left(a_j^* - a_{ij}\right)}{a_j^* - a_{ij}}\ ;\ R_i = \max_j \left[\frac{w_j\left(a_j^* - a_{ij}\right)}{a_j^* - a_{ij}}\right]$$

$$S^* = \min_i S_i\ ;\ S^- = \max_i S_i;\ R^* = \min_i R_i\ ;\ R^- = \max_i R_i$$

According to VIKOR, the optimal solution must comply with two criteria of acceptability:

- Acceptable advantage, $Q\ (A'') - Q\ (A') \geq DQ$, with $DQ = 1/(n - 1)$, where n is the number of alternatives;
- Acceptable stability of the decision, that is, the alternative A' must also be the best, or in the ranking must present the minimum value in terms of S_i and/or R_i.

If one of the two conditions is not verified, it is impossible to directly determine the best solution, which is obviously a limitation of the method. In this case, a set of compromised solutions is established in the set of alternatives under consideration. This set is given by:

- Alternatives A' and A'', if only condition 2 is not satisfied;
- Alternatives A', A'', ..., A^N, if only condition 1 is not met.

A^N is the last solution, taken in the order obtained according to Q_i, for which the inequality is still valid:

$$Q\ (A^N) - Q\ (A') < DQ.$$

The alternatives of the set thus determined are characterized by a sensitive reciprocal "closeness".

The essential examination of the four methods, AHP, ELECTRE, TOPSIS, and VIKOR aimed at a useful comparison to highlight the peculiarities of each of them, is summarized in Table 2.

Table 2. Comparison between multi-criteria methods.

Method	Number of Criteria	Number of Alternatives	Algorithm Structure	Ranking	Solution
AHP	Large	Limited	Pairwise comparison	Score ranking	Best alternative of all according to criteria and sub-criteria
ELECTRE	Limited	Limited	Preference thresholds	Preference ranking	Not dominated alternative
TOPSIS	Large	Large	Ideal solution and negative ideal solution	Score ranking	Alternative closer to the ideal solution and at the same time more distant from the ideal negative solution
VIKOR	Large	Large	Ideal solution	Score ranking	Alternative closer to the ideal solution

4. Selection of the Best Use of a Historic Building. Characterization of a Hierarchical Analysis Model

The Analytic Hierarchy Process is defined as "analytical" because it breaks down the complex decision problem into fundamental constituent elements [30,31,41,42]; "hierarchical" because the breakdown of the problem itself occurs at successive levels characterized by ever-increasing detail [27,28,43,44]. At the top of the hierarchy, there is the goal to be reached, which, in the case under consideration, is given by the best use for the historic building.

The choice of indicators is fundamental for the correct application of the model. Here, they have been selected from literature datasets [45–48].

At the first level, we consider the social (*C1*), cultural (*C2*), and financial (*C3*) criteria, which are described in turn in the sub-criteria. In particular, the social criterion includes the sub-criteria:

- *Community involvement* (C_1), intended as the average number of daily users. It is measured as the average daily number of people who attend the structure;
- *New workers* (C_2), measured as the number of new workers in the structure.
- The cultural criterion includes the sub-criteria:
- *Cultural effects* (C_3), understood as the attraction of the structure with respect to cultural events;
- *Compatibility of the function with the historical-architectural characteristics of the property* (C_4). This criterion depends on the three sub-criteria:
- *Representativeness of the use function* (C_{41}), evaluated as the aptitude to express the cultural peculiarities of the reference territory, in respect of the material and spiritual reality of the architectural artefact;
- *Residential impact* (C_{42}), understood as the average number of daily users, in this case with a negative meaning, in the sense that higher this number is, the lower the score attributed to the alternative is. In fact, with the aim of protecting the cultural asset, it is advisable to prefer functional activities with a moderate residential impact, in order to avoid excessive loads on the structure that may require interventions of static adaptation such as to compromise the authenticity of the historical matter;
- *Respect of the criterion of minimum intervention* (C_{43}), that is, safeguarding the characteristics of the building. It is necessary to avoid intrusive interventions, such as new openings, tracks for installations, partitions, kitchens, and toilets, so as not to reduce the artistic-monumental quality of the property. This criterion represents one of the cardinal principles of architectural restoration and conservation of historic buildings. It is therefore a qualitative, rather than a quantitative criterion [49,50].

The financial criterion includes the sub-criterion:

- *Return On Investment* (C_5). This is measured by ROI (Return On Investment), which expresses the rate of return on the total investments of a company for the assumed activity.

According to the existing technical-urban planning constraints and in relation to the socio-demographic and economic characteristics of the territory in which the recovery and enhancement project of the historic building is inserted, the analysts define the possible investment alternatives A_1, A_2, ..., A_n. Among these, it is necessary to make the choice that guarantees the optimal use, according to the multiple criteria *C1*, *C2*, *C3* and sub-criteria C_1, C_2, C_3, C_4, C_5, as well as C_{41}, C_{42}, and C_{43} defined above. The logical-operative scheme outlined finds graphic representation in Figure 1.

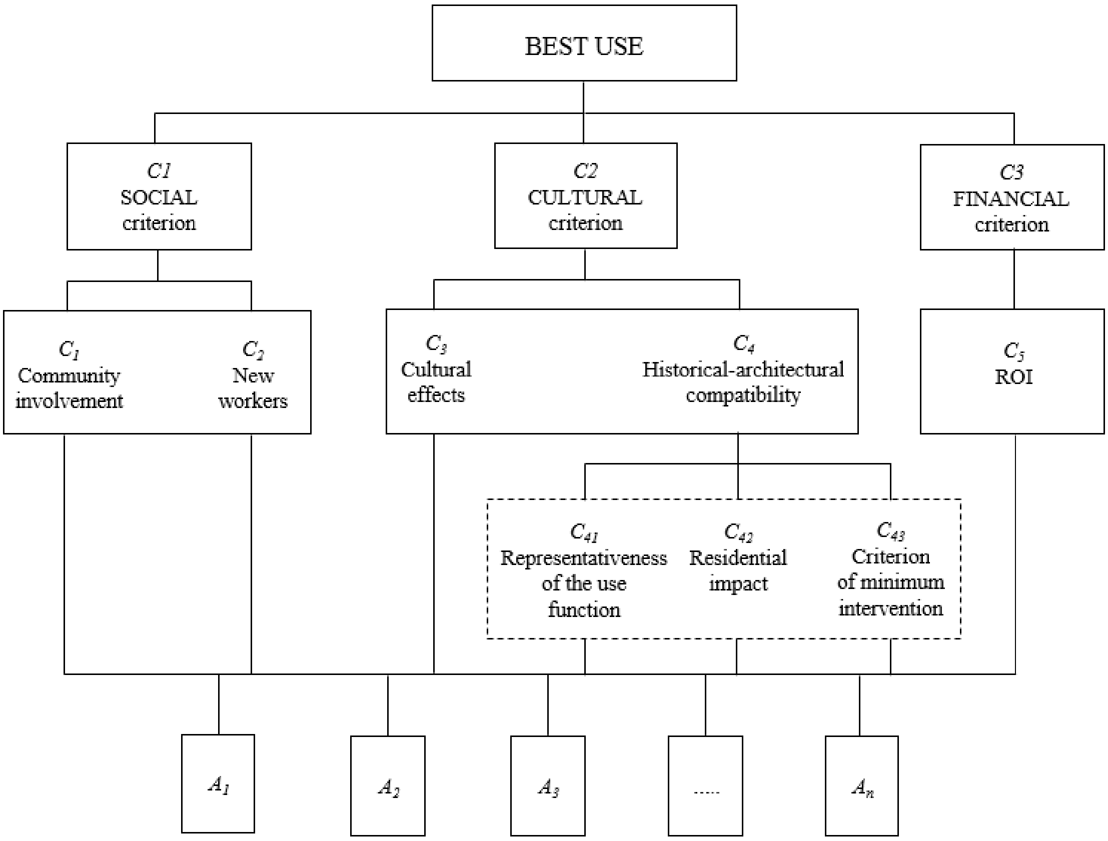
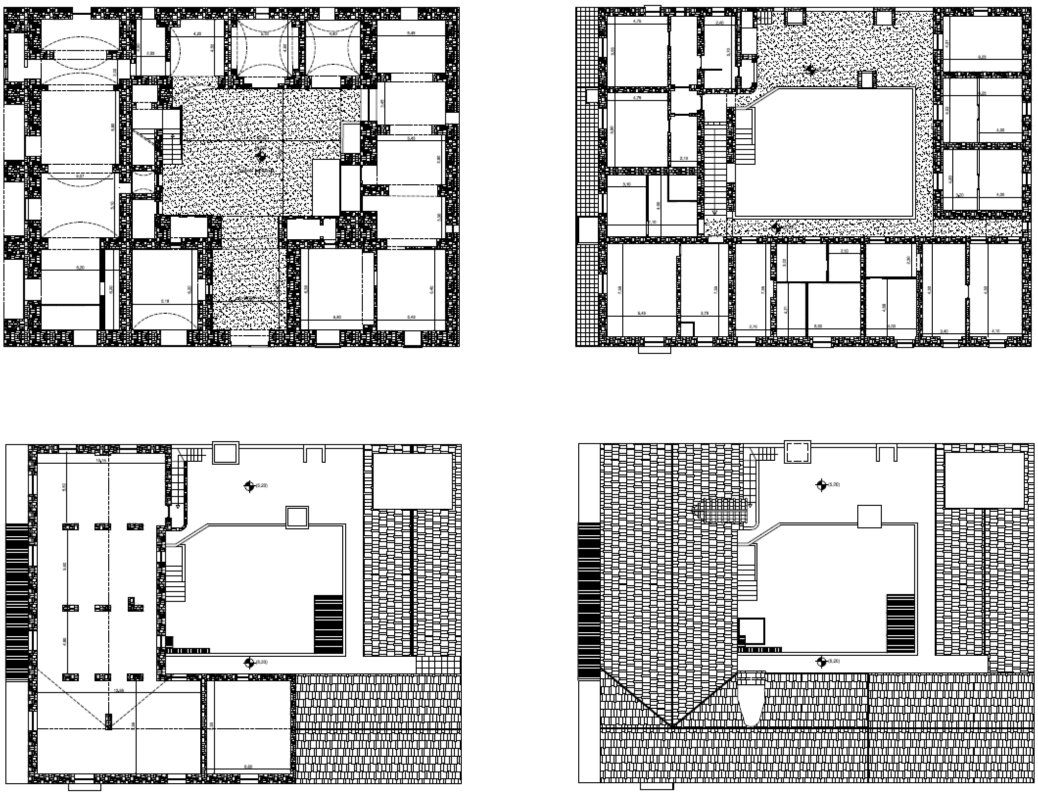


Figure 1. Hierarchical structure of the proposed model.

5. Case Study and Results

The aim of the paper was to define the best use for the recovery and enhancement of a former convent in the province of Salerno (Italy). For this purpose, in accordance with the provisions of paragraph 3, the Analogue Hierarchy Process was used. This is a multi-criteria approach able to take into account both the use value of cultural heritage as a source of economic growth in the short term, and its intrinsic value as an identity element of a community, to be preserved in the long term [51].

The monastic complex under study is of particular historical-architectural interest, but is currently in a very poor state of preservation. Thus, the public administration acquired the property with the aim of recovering it [52–55]. Figure 2 shows the plants, sections, and main elevations of the building in the actual state.



A.

B.

C.

Figure 2. Former convent in the province of Salerno (Italy): (**A**). plans; (**B**). sections; (**C**). elevations.

Depending on the technical-urban planning constraints and the economic characteristics of the area in which the historic building is located, possible uses are:

- Bed & Breakfast (A_1);
- Multi-purpose rooms (A_2) for holding conferences, seminars, thematic meetings, exhibitions and multimedia workshops;
- Local cuisine restaurant (A_3), which proposes traditional dishes, cooking workshops, as well as workshops for the valorization of the typical craftsmanship of the places, with an adjoining museum of rural civilization;

- Public and private offices (A_4).

The Figures A1–A12 in the Appendix A report the functional distribution of the internal spaces at the three levels of the building for each of the four solutions of use.

The AHP was developed according to the first-level evaluation criteria: social (C_1), cultural (C_2), and financial (C_3). For the case in question, the sub-criteria are estimated as follows:

- *Community involvement* (C_1). As there is no data on the average number of users, a filling index was envisaged as a rate of the maximum capacity of the structure;
- *New workers* (C_2). This data was obtained through surveys carried out in similar structures in the territory;
- *Cultural effects* (C_3). This is expressed as the ratio between the surface used for cultural activities (S_C) and the total area of the building (S_T);
- *Compatibility of the function with the historical-architectural characteristics of the property* (C_4). This criterion depends on the three sub-criteria:
- *Representativeness of the use function* (C_{41}), according to a judgment scale from 1–7;
- *Residential impact* (C_{42}), assessed as for criterion C_1;
- *Respect of the criterion of minimum intervention* (C_{43}). The judgment was assigned by the decision-maker according to a qualitative scale from 1–7, depending on the level of protection that is guaranteed to the original structure;
- *Return On Investment, ROI* (C_5). For each of the four alternatives, the *ROI* value was derived from information on the profitability of the reference economic sector in the area of investigation.

Once the alternatives, criteria, and sub-criteria for the evaluation was defined, the hierarchical decision model was outlined, as shown in Figure 3.

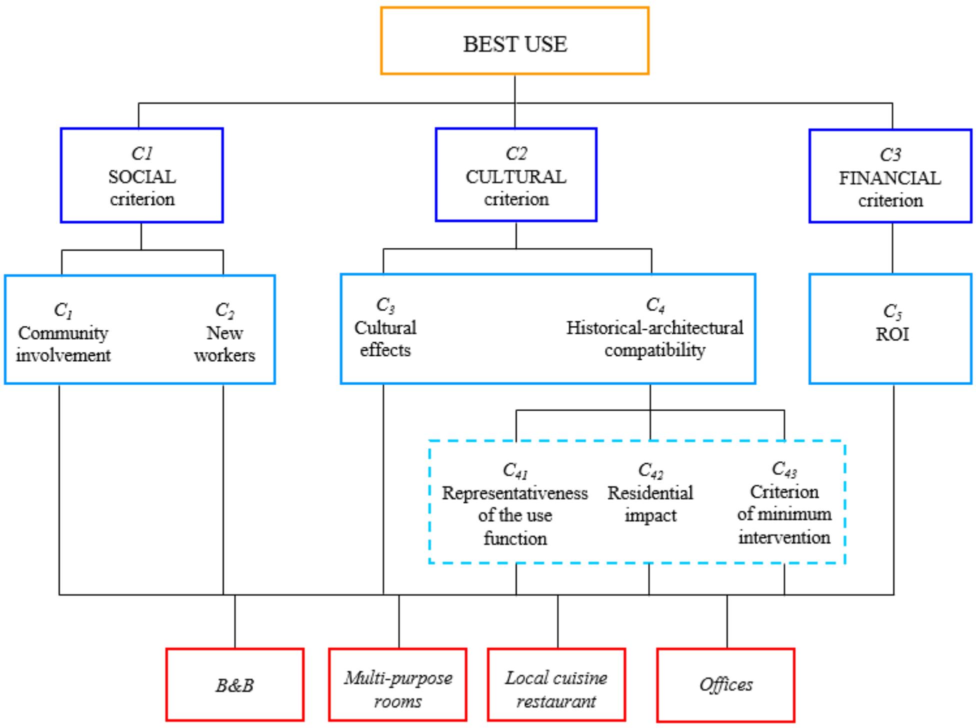


Figure 3. The hierarchical structure for the case study.

Table 3 shows the scalarized decision matrix, useful for the implementation of the AHP. In this matrix the generic element a_{ij} (attribute) expresses the performance of the generic alternative *Ai* ($i = 1, 2, \ldots, n$) with respect to the generic criterion C_j ($j = 1, 2, \ldots, m$) [56,57].

Table 3. Scalarized decision matrix.

	C_1	C_2	C_3	C_{41}	C_{42}	C_{43}	C_5
	Community Involvement	**New Workers**	**Cultural Effects**	**Representativeness of the Use Function**	**Residential Impact**	**Criterion of Minimum Intervention**	**ROI**
	[n. users]	**[n. workers]**	**[m^2/m^2]**		**[n. users]**		**[€/€]**
A_1	122	14	0.335	5	122	3	0.073
A_2	168	16	0.661	6	168	6	0.043
A_3	197	22	0.641	6	197	4	0.122
A_4	140	16	0.205	3	140	5	0.101

The dominance coefficients were assigned according to Saaty's semantic scale in Table 4. They are representative of the relative importance between the compared elements [33].

Table 4. Saaty semantic scale.

Intensity	**1**	**3**	**5**	**7**	**9**	**2, 4, 6, 8**
Linguistic	Equal	Moderate	Strong	Demonstrated	Extreme	Intermediate values

In paired comparisons of the alternatives with respect to the criteria, graduated scales were used, each divided into equal bands corresponding to the intensity of the Saaty scale, where the maximum value of the indicator in question corresponds to the upper end. On the scale thus defined, the numerical values of the indicators have been positioned for each alternative (Figure 4). If there is only one band between the indicators, then the strongest value was given coefficient 3, and to the other, the reciprocal; if there are two bands, the strongest value was assigned coefficient 5, and to the other, the reciprocal, and so on. In intermediate situations, there were intermediate intensities.

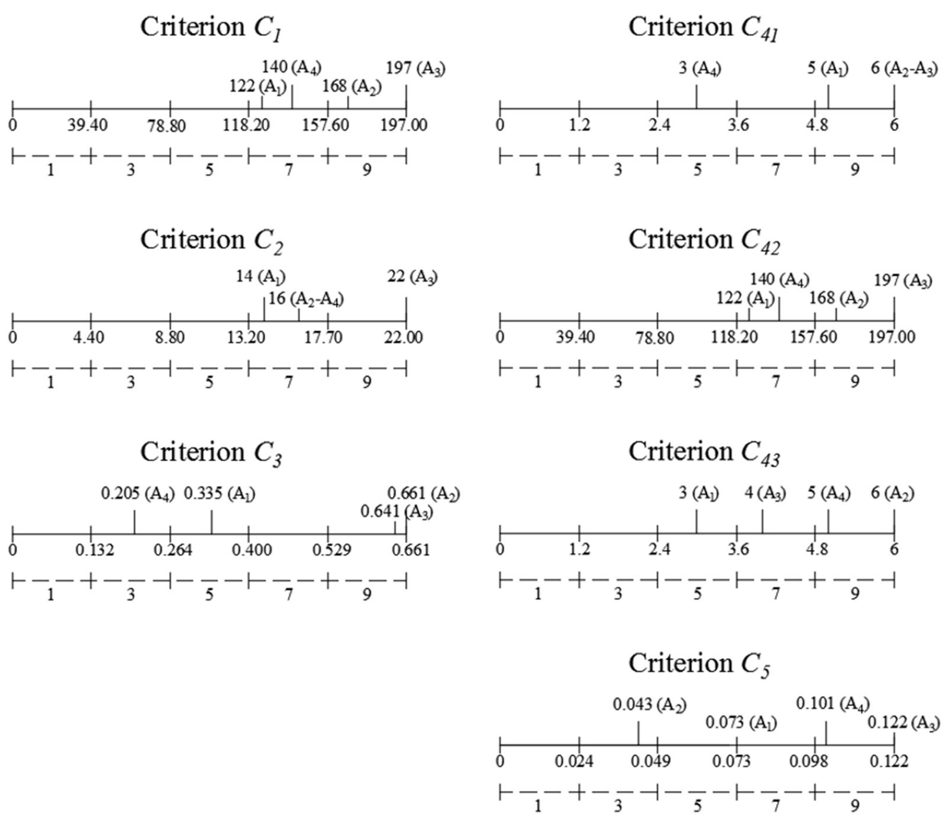


Figure 4. Scales for determining the dominance coefficients.

Table 5 contains the matrices of pairwise comparisons and the matrices of normalized pair comparisons. From these matrices, processed by implementing Microsoft Excel software, it was possible to obtain the weights of each alternative with respect to each sub-criterion. In all cases, the matrices are consistent. In fact, being of rank 4, they have a value of consistency ratio lower than 9.

Table 5. Comparison matrices in pairs between the alternatives with respect to each criterion.

C_1–Community Involvement					**C_1–Community Involvement**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	0.33	0.20	1.00	A_1	0.100	0.071	0.112	0.111	0.099
A_2	3.00	1.00	0.33	3.00	A_2	0.300	0.214	0.187	0.333	0.259
A_3	5.00	3.00	1.00	4.00	A_3	0.500	0.643	0.561	0.444	0.537
A_4	1.00	0.33	0.25	1.00	A_4	0.100	0.071	0.140	0.111	0.106
$CR = 3.80$					$CR = 3.80$					
C_2–New workers					**C_2–New workers**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	1.00	0.20	1.00	A_1	0.125	0.143	0.118	0.143	0.132
A_2	1.00	1.00	0.25	1.00	A_2	0.125	0.143	0.147	0.143	0.139
A_3	5.00	4.00	1.00	4.00	A_3	0.625	0.571	0.588	0.571	0.589
A_4	1.00	1.00	0.25	1.00	A_4	0.125	0.143	0.147	0.143	0.139
$CR = 0.38$					$CR = 0.38$					
C_3–Cultural effects					**C_3–Cultural effects**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	0.17	0.20	3.00	A_1	0.081	0.073	0.085	0.158	0.099
A_2	6.00	1.00	1.00	8.00	A_2	0.486	0.436	0.427	0.421	0.443
A_3	5.00	1.00	1.00	7.00	A_3	0.405	0.436	0.427	0.368	0.409
A_4	0.33	0.13	0.14	1.00	A_4	0.027	0.055	0.061	0.053	0.049
$CR = 4.62$					$CR = 4.62$					
C_{41}—Representativeness of the use function					**C_{41}—Representativeness of the use function**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	0.33	0.33	5.00	A_1	0.139	0.133	0.133	0.278	0.171
A_2	3.00	1.00	1.00	6.00	A_2	0.417	0.400	0.400	0.333	0.388
A_3	3.00	1.00	1.00	6.00	A_3	0.417	0.400	0.400	0.333	0.388
A_4	0.20	0.17	0.17	1.00	A_4	0.028	0.067	0.067	0.056	0.054
$CR = 5.28$					$CR = 5.28$					
C_{42}—Residential impact					**C_{42}—Residential impact**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	3.00	5.00	1.00	A_1	0.395	0.409	0.385	0.387	0.394
A_2	0.33	1.00	3.00	0.33	A_2	0.132	0.136	0.231	0.129	0.157
A_3	0.20	0.33	1.00	0.25	A_3	0.079	0.045	0.077	0.097	0.075
A_4	1.00	3.00	4.00	1.00	A_4	0.395	0.409	0.308	0.387	0.375
$CR = 3.16$					$CR = 3.16$					
C_{43}—Criterion of minimum interventation					**C_{43}—Criterion of minimum interventation**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	0.17	0.33	0.20	A_1	0.067	0.098	0.036	0.044	0.061
A_2	6.00	1.00	5.00	3.00	A_2	0.400	0.588	0.536	0.662	0.546
A_3	3.00	0.20	1.00	0.33	A_3	0.200	0.118	0.107	0.074	0.125
A_4	5.00	0.33	3.00	1.00	A_4	0.333	0.196	0.321	0.221	0.268
$CR = 8.26$					$CR = 8.26$					
C_5—ROI					**C_5—ROI**					
	A_1	A_2	A_3	A_4		A_1	A_2	A_3	A_4	w_i
A_1	1.00	3.00	0.20	0.33	A_1	0.107	0.188	0.119	0.074	0.122
A_2	0.33	1.00	0.14	0.20	A_2	0.036	0.063	0.085	0.044	0.057
A_3	5.00	7.00	1.00	3.00	A_3	0.536	0.438	0.597	0.662	0.558
A_4	3.00	5.00	0.33	1.00	A_4	0.321	0.313	0.199	0.221	0.263
$CR = 6.54$					$CR = 6.54$					

In the preparation of the matrices of pairwise comparisons, both between criteria and between sub-criteria, we assigned equal weight to each criterion, and with reference to the single criterion, we assigned the same weight to each sub-criterion. All matrices were consistent.

The total priorities are shown in Table 6. The AHP therefore identifies the local cuisine restaurant as the best destination for the recovery and enhancement of the former convent.

Table 6. Priority matrix.

	$C1$ (Social)			**$C2$ (Cultural)**			**$C3$ (Financial)**	**Priority**
w_{Ci}	*0.333*			*0.333*			*0.333*	
	C_1	C_2	C_3	C_4			C_5	
w_{Ci}	0.500	0.500	0.500	*0.500*			1.00	
				C_{41}	C_{42}	C_{43}		
w_{Ci}				0.333	0.333	0.333		
w_{A1}	0.099	0.132	0.099	0.171	0.394	0.061	0.122	0.130
w_{A2}	0.259	0.139	0.443	0.388	0.157	0.546	0.057	0.220
w_{A3}	0.537	0.589	0.409	0.388	0.075	0.125	0.558	**0.474**
w_{A4}	0.106	0.139	0.049	0.054	0.375	0.268	0.263	0.175

6. Discussion

The selection of possible alternatives of use for the historical building under study was derived from a careful analysis of the needs of citizenship, and from the economic and socio-demographic characteristics of the reference territory. In particular, the choice of the B&B was born from the need to improve the reception services connected to the use of the existing historical, architectural, and archaeological heritage. The multi-purpose hall option was aimed at the cultural growth of the city, which was also poorly equipped with facilities for conferences, seminars, and professional training. The local cuisine restaurant destination with its museum of rural civilization intends to recover the building as the driving force of an economy capable of enhancing the typical local products, as in the past, the convent—thanks to the presence of Benedictine monks—was a point of reference for the agricultural development of a marginal area. The office function can allow the urban center to play a central economic role.

Table 5 of the priorities shows that, due to the multiple evaluation criteria considered, the AHP method considers A_3 as the best alternative. Thus, the optimal use is that of the local cuisine restaurant, with a score of 0.474. In the order of the alternatives: A_2 (multi-purpose rooms) with a score of 0.220, that is less than half of the valid score for the first solution in the ranking; A_4 (offices) with a score of 0.175; and A_1 (bed & breakfast) with a score of 0.130.

7. Conclusions

Historical environments are an exhaustible resource, so it requires great attention in terms of protection, but also of enhancement. This can happen through the functional recovery of the building with the identification of its best use, intended as a function able to simultaneously maximize the social, cultural, and financial effects that the intervention on the historic building generates on the reference territory. This approach respects the principles of sustainable urban development.

The aim of the research is to outline a multi-criteria evaluation model able to select the optimal function for a historic building in a state of neglect. From this point of view, a comparative analysis was carried out on some of the most well-known Multi-Criteria Decision Making methods: the Analitic Hierarchy Process (AHP), ELimination Et Choix Traduisant la REalité (ELECTRE), Tecnique for Order Preference by Similarity to Ideal Solution (TOPSIS), and the Compromise Ranking Method (VIKOR). The theoretical examination highlights that, due to its hierarchical structure, the AHP model allows the problem to be broken down to the level of detail necessary for the analysis, thus being more effective in solving the problem in question, where, very often, there are multiple criteria and sub-criteria of evaluation.

For the correct implementation of the hierarchical analysis algorithms, the rigorous selection of the evaluation criteria and sub-criteria, as well as the corresponding indicators, is fundamental. This selection represents an element of novelty of the research. The study led us to recognize: the social criteria, which can be expressed through the community involvement and the new workers; cultural criteria, translated in terms of cultural effects and compatibility of the function with the historical-architectural characteristics of the property; and financial criteria, to be expressed quantitatively by the Return On Investment. It should be noted that a careful study on the compatibility of the function with the historical-architectural characteristics of the property leads to a breaking down of this criterion into the three interventions.

The operational coherence of the evaluation model is verified through a case study, concerning the selection of the optimal destination for a former convent in the province of Salerno (Italy).

The multi-criteria analysis model proved to be an effective decision support tool, guaranteeing to both public administrations and private individuals an optimal allocation of available resources, with obvious and important implications of economic policy.

Author Contributions: Conceptualization, A.N.; Data curation, A.N and P.S.; Formal analysis, A.N. and P.S.; Methodology, A.N. and P.S.; Software, A.N. and P.S.; Supervision, A.N.; Validation, A.N.; Writing—original draft, A.N. and P.S.; Writing—review & editing, A.N.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Figure A1. B&B ground floor plan.

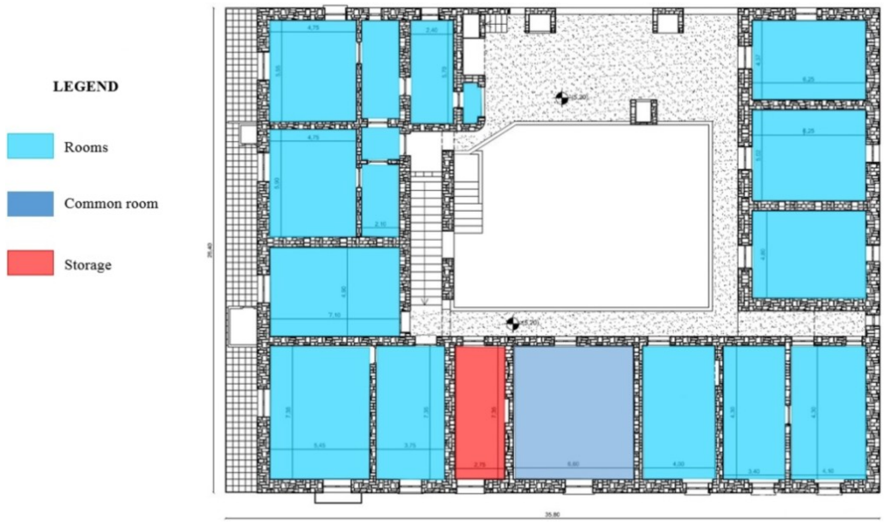


Figure A2. B&B first floor plan.

Figure A3. B&B attic floor plan.

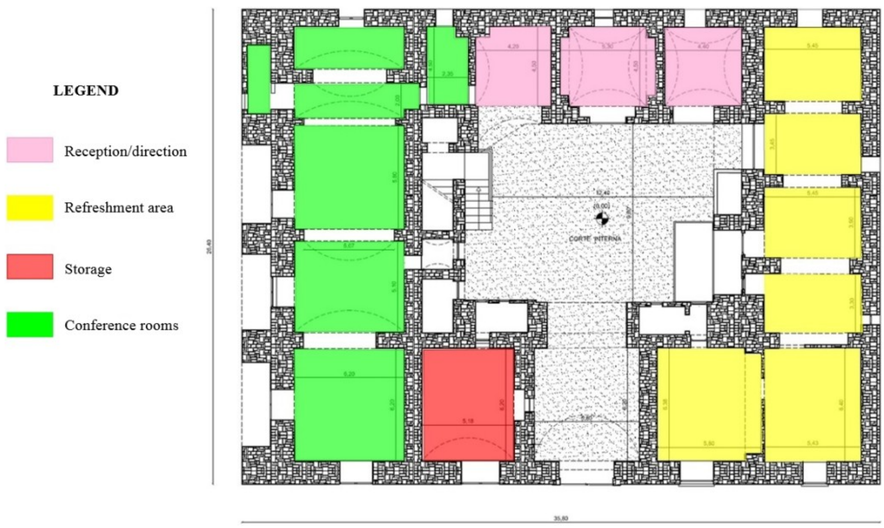


Figure A4. Multi-purpose rooms ground floor plan.

Figure A5. Multi-purpose rooms first floor plan.

Figure A6. Multi-purpose rooms attic floor plan.

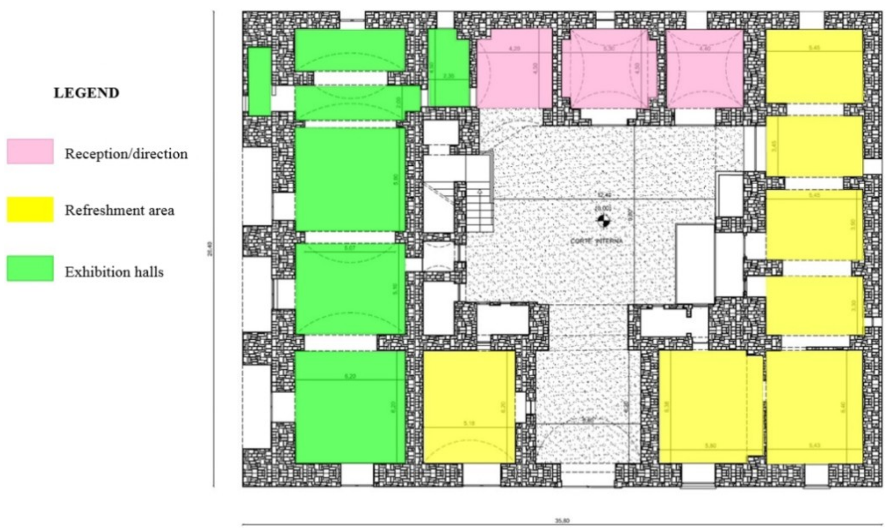


Figure A7. Local cuisine restaurant ground floor plan.

Figure A8. Local cuisine restaurant first floor plan.

Figure A9. Local cuisine restaurant attic floor plan.

Figure A10. Offices' ground floor plan.

Figure A11. Offices' first floor plan.

Figure A12. Offices' attic floor plan.

References

1. Nesticò, A.; Sica, F. The sustainability of urban renewal projects: A model for economic multi-criteria analysis. *J. Prop. Invest. Financ.* **2017**, *35*, 397–409. [CrossRef]
2. Di Ruocco, G.; Nesticò, A. Archaeological Site Conservation and Enhancement: An Economic Evaluation Model for the Selection of Investment Projects. *Sustainability* **2018**, *10*, 3907. [CrossRef]
3. Ministero dell'ambiente e della tutela del territorio e del mare. In Proceedings of the Le Infrastrutture verdi e i servizi Ecosistemici in Italia Come Strumento per le politiche Ambientali e la Green Economy: Potenzialità, Criticità e proposte, In Conference La Natura dell'Italia, Rome, Italy, 11–12 December 2013.
4. Maskey, V.; Brown, C.; Lin, G. Assessing factors associated with listing a historic resource in the national register of historic places. *Econ. Dev. Q.* **2009**, *4*, 342–350. [CrossRef]
5. Phillips, R.G.; Burdruk, M. *Introduction to Quality of Life and Community Indicators for Parks, Recreation and Tourism Management*; Springer: Dordrecht, The Netherlands, 2010.
6. Throsby, D. Heritage Economics: A conceptual framework. In *The Economics of Uniqueness. Investing in Historic City Cores and Cultural Heritage Assets for Sustainable Development*; Licciardi, G., Amirtahmasebi, R., Eds.; World Bank Group: Washington, DC, USA, 2012; pp. 45–74.
7. Nesticò, A.; Guarini, M.R.; Morano, P.; Sica, F. An Economic Analysis Algorithm for Urban Forestry Projects. *Sustainability* **2019**, *11*, 314. [CrossRef]

8. Cascone, S.; Sciuto, G. Nuove identità per edifici dismessi in centro storico. *Recupero Conserv.* **2016**, *133*, 27.
9. Della Spina, L. Evaluation Decision Support Models: Highest and Best Use choice. *Procedia Soc. Behav. Sci.* **2016**, *223*, 936–943. [CrossRef]
10. Nesticò, A.; Macchiaroli, M.; Pipolo, O. Costs and Benefits in the Recovery of Historic Buildings: The Application of an Economic Model. *Sustainability* **2015**, *7*, 14661–14676. [CrossRef]
11. Ribera, F.; Nesticò, A.; Cucco, P.; Maselli, G. A multicriteria approach to identify the Highest and Best Use for historical buildings. *J. Cult. Herit.* **2019**. [CrossRef]
12. Mosetto, G.; Vecco, M. *Economia del Patrimonio Monumentale*; FrancoAngeli: Milan, Italy, 2001.
13. De La Torre, M. *Assessing the Values of the Cultural Heritage*; Getty Conservation Institute: Los Angeles, CA, USA, 2002.
14. Fusco Girard, L.; Nijkamp, P. *La valutazione per lo Sviluppo Sostenibile Della Città e del Territorio*; FrancoAngeli: Milan, Italy, 1997.
15. Pompili, T.; Travisi, C.M.; Ruggeri, G. La valutazione di attività complementari alle attività agricole nelle aree rurali e periurbane della provincia di Milano: Un approccio multicriteri. In Proceedings of the XXV Conferenza Italiana di Scienze Regionali, Novara, Italy, 6–8 october 2004.
16. Nesticò, A. Risk-Analysis Techniques for the Economic Evaluation of Investment Projects. In *Integrated Evaluation for the Management of Contemporary Cities. SIEV 2016. Green Energy and Technology*; Mondini, G., Fattinnanzi, E., Oppio, A., Bottero, M., Stanghellini, S., Eds.; Springer: Cham, Switzerland, 2018; pp. 617–629. [CrossRef]
17. Nesticò, A.; Moffa, R. Economic analysis and Operational Research tools for estimating productivity levels in off-site construction [Analisi economiche e strumenti di Ricerca Operativa per la stima dei livelli di produttività nell'edilizia off-site]. *Valori Valutazioni* **2018**, *20*, 107–126.
18. Nesticò, A.; Morano, P.; Sica, F. A model to support the public administration decisions for the investments selection on historic buildings. *J. Cult. Herit.* **2018**, *33*, 201–207. [CrossRef]
19. Mavrotas, G. Effective implementation of the ε-constraint method in multi-objective mathematical programming problems. *Appl. Math. Comput.* **2009**, *213*, 455–465. [CrossRef]
20. Pompili, T. Metodologie di valutazione economica: Una rassegna sistematica. In *Valutazione Economica e Strategica di Programmi e Progetti Territoriali*; FrancoAngeli: Milan, Italy, 2006.
21. Nesticò, A.; He, S.; De Mare, G.; Benintendi, R.; Maselli, G. The ALARP Principle in the Cost-Benefit Analysis for the Acceptability of Investment Risk. *Sustainability* **2018**, *10*, 4668. [CrossRef]
22. Pons, O.; De la Fuente, A.; Aguado, A. The Use of MIVES as a Sustainability Assessment MCDM Method for Architecture and Civil Engineering Applications. *Sustainability* **2016**, *8*, 460. [CrossRef]
23. Figueira, J.; Greco, S.; Ehrgott, M. *Multiple Criteria Decision Analysis: State of the Art Surveys*; Springer Science & Business Media: New York, NY, USA, 2005; Volume 78.
24. Figueira, J.; Greco, S.; Roy, B.; Stowinski, R. An overview of ELECTRE methods and their recent extensions. *J. Multi Criteria Decis. Anal.* **2013**, *20*, 61–85. [CrossRef]
25. Hwang, C.L.; Yoon, K. *Multiple Attribute Decision Making, Lecture Notes in Economics and Mathematical System n. 186*; Springer: Berlin, Germany, 1981.
26. Opricovic, S.; Tzeng, G.H. Extended VIKOR method in comparison with outranking methods. *Eur. J. Oper. Res.* **2007**, *178*, 514–529. [CrossRef]
27. Roy, B. *How outranking relation helps multiple criteria decision making, Multiple Criteria Decision Making, Actes du Séminaire "Théorie de la Décision"*; Beaulieu-Sainte-Assise: Francia, 1973.
28. Roy, B. *Méthodologie Multicritére D'aide à la Decision*; Economica: Paris, France, 1985.
29. Saaty, T.L. *The Analytic Hierarchy Process*; McGraw-Hill: New York, NY, USA, 1977.
30. Saaty, T.L. A Scaling Method for Priorities in Hierarchy Structures. *J. Math. Psychol.* **1980**, *15*, 234–281. [CrossRef]
31. Saaty, T.L. How to make a decision: The Analytic Hierarchy Process. *Eur. J. Oper. Res.* **1990**, *48*, 9–26. [CrossRef]
32. Saaty, T.L. *Decision Making for Leaders: The Analytic Hierarchy Process for Decision in a Complex Word*; RWS Publications: Pittsburg, CA, USA, 1999.
33. Tzeng, G.H.; Huang, J.J. *Multiple Attribute Decision Making Methods and Applications*; CRC Press, Taylor & Francis Group: Boca Raton, FL, USA, 2011.
34. Velasquez, M.; Hester, P.T. An Analysis of Multi-Criteria Decision Making Methods. *Int. J. Oper. Res.* **2013**, *10*, 56–66.
35. Vincke, P. *Multicriteria Decision-Aid*; John Wiley & Sons: Hoboken, NJ, USA, 1992.

36. Zanakis, S.H.; Solomon, A.; Wishart, N.; Dublish, S. Multi-attribute decision making: A simulation comparison of select methods. *Eur. J. Oper. Res.* **1998**, *107*, 507–529. [CrossRef]
37. Mela, K.; Tiainen, T.; Heinisuo, M. Comparative study of multiple criteria decision making methods for building design. *Adv. Eng. Inform.* **2012**, *26*, 716–726. [CrossRef]
38. Forman, E.H. *The Analytic Hierarchy Process: An Exposition, School of Business and Public Management*; George Washington University: Washington, DC, USA, 2001.
39. Basak, I. Estimation of priority weights based on a resampling technique and a ranking method in analytic hierarchy process. *J. Multi Criteria Decis. Anal.* **2019**. [CrossRef]
40. Fishburn, P.C. *Additive Utilities with Incomplete Product Set: Applications to Priorities and Assignments*; ORSA: Baltimora, MD, USA, 1967.
41. Saaty, T.L. Decision making with the analytic hierarchy process. *Int. J. Serv. Sci.* **2008**, *1*, 83–98. [CrossRef]
42. Calabrò, F.; Della Spina, L. Innovative Tools for the Effectiveness and Efficiency of Administrative Action of the Metropolitan Cities: The Strategic Operational Programme. In *1th international Symposium New Metropolitan Perspectives—The Integrated Approach of Urban Sustainable Development (ISTH2020), Advanced Engineering Forum*; Trans Tech Publications: Switzerland, Zurich, 2014; Volume 11, pp. 3–10.
43. Yau, Y. Multi-criteria decision making for urban built heritage conservation: Application of the analytic hierarchy process. *J. Build. Apprais.* **2008**, *4*, 191–205. [CrossRef]
44. Nijkamp, P.; Rietveld, P.; Voogd, H. *Multicriteria Evaluation in Physical Planning*; North Holland Publications: Amsterdam, The Netherland, 1990.
45. UNESCO. *Budapest Declaration on Word Heritage*; UNESCO: Budapest, Hungary, 2002.
46. Chan, E.H.W.; Lee, G.K.L. Critical factors for improving social sustainability of urban renewal projects. *Soc. Indic. Res.* **2007**, *85*, 243–256. [CrossRef]
47. Zancheti, S.; Hidaka, L. Measuring urban heritage conservation: Indicator, weights and instruments (part. 2). *J. Cult. Herit. Manag. Sustain. Dev.* **2012**, *2*, 15–16. [CrossRef]
48. Phillips, R.G.; Stein, J.M. An indicator frameworkfor linking historic preservation and community economic development. *Soc. Indic. Res.* **2013**, *113*, 1–15. [CrossRef]
49. Petzet, M. Principles of Preservation: An Introduction to the International Charters for Conservation and Restoration 40 years after the Venice Charter. In *International Charters for Conservation and Restoration Monuments & Sites*; ICOMOS: München, Germany, 2004.
50. Pellegri, P.C. *Manuale del Riuso Architettonico: Sostenibilità e Compatibilità Ambientale Nella Scelta dei Materiali e Delle Tecnologie*; Flaccovio Editore: Palermo, Italy, 2018.
51. Fusco Girard, L.; Nijkamp, P. *Energia, Bellezza, Partecipazione: La sfida della Sostenibilità. Valutazioni Integrate tra Conservazione e Sviluppo*; Angeli: Milano, Italy, 2004.
52. Fiore, P.; Nesticò, A.; Macchiaroli, M. The energy improvement of monumental buildings. An investigation protocol and case studies La riqualificazione energetica degli edifici monumentali. Un protocollo di intervento e caso studio. *Valori Valutazioni* **2016**, *16*, 45–55.
53. De Mare, G.; Granata, M.F.; Nesticò, A. Weak and Strong Compensation for the Prioritization of Public Investments: Multidimensional Analysis for Pools. *Sustainability* **2015**, *7*, 16022–16038. [CrossRef]
54. De Mare, G.; Manganelli, B.; Nesticò, A. Dynamic Analysis of the Property Market in the City of Avellino (Italy). In *The Wheaton-Di Pasquale Model Applied to the Residential Segment*; Murgante, B., Misra, S., Carlini, M., Torre, C., Nguyen, H.Q., Taniar, D., Apduhan, B.O., Gervasi, O., Eds.; Springer-Verlag: Berlin/Heidelberg, Germany, 2013; Volume 7973, pp. 509–523. [CrossRef]
55. Della Spina, L. Historical Cultural Heritage: Decision Making Process and Reuse Scenarios for the Enhancement of Historic Buildings. In *New Metropolitan Perspectives. ISHT 2018. Smart Innovation, Systems and Technologies*; Calabrò, F., Della Spina, L., Bevilacqua, C., Eds.; Springer: Cham, Switzerland, 2019; Volume 101. [CrossRef]
56. Triantaphyllou, E. *Multi-Criteria Decision Making Methods: A Comparative Study, Applied Optimization 44*; Kluwer Academic Publisher: Dordrecht, The Netherland, 2002.
57. Zimmermann, H.J. *Fuzzy Set Theory and Its Applications*; Third Revised Edition; Kluer Academy Publishers: Boston, MA, USA, 1996.