Supporting the Resources Allocation for Inner Areas by the Use of the FITradeoff Method

Marta Dell'Ovo[1](✉), Alessandra Oppio[1], Eduarda Asfora Frej[2], and Adiel Teixeira de Almeida[2]

[1] Department of Architecture and Urban Studies (DAStU), Politecnico di Milano, Via Bonardi, 3, 20133 Milano, Italy
{marta.dellovo,alessandra.oppio}@polimi.it

[2] CDSID - Center for Decision Systems and Information Development, Universidade Federal de Pernambuco – UFPE, Av. Acadêmico Hélio Ramos, s/n – Cidade Universitária, Recife, PE 50740-530, Brazil
{eafrej,almeida}@cdsid.org.br

Abstract. Slow Tourism is recognized as a driver able to enhance sustainable development in fragile areas characterized by the distance from centers offering essential services, low level of accessibility and affected by depopulation. In this context it is strategic to adopt robust methodologies able to invert this trend and to answer in an effective way to this issue. It is moreover important to identify the peculiarities of each area in order to define specific strategies to be applied. The current research aims to propose and test a methodology to support the Decision Makers (DM) in allocating resources for the valorization of minor real estate heritage for the regeneration of the entire territory by understanding which assets deserve or are more strategic to be renewed. The FITradeoff method (Flexible and Interactive Tradeoff) has been applied to solve the decision problem and support the DM in making a coherent choice in line with the characteristic of the territory.

Keywords: Slow tourism · Multicriteria decision-making (MCDM) · FITradeoff method · Decision Support System (DSS)

1 Introduction

The National Strategy for Inland Areas (SNAI) is an Italian public policy aimed at tackling depopulation in inner areas, which are defined and classified according to their distance from centers offering essential services and their level of accessibility [1]. In this context, SNAI's main objective is to reverse the demographic trend in these territories, to be pursued through two main actions: a) the first focuses on adapting the supply of essential services in order to create the conditions for the development of the territory; b) the second aims at implementing actions in favor of local development, intended to generate labor demand through the reuse and enhancement of territorial capital. Moreover, the Covid-19 pandemic has accelerated the process of both economic and qualitative impoverishment of these places, congesting health services, causing difficulties for certain sectors of work and their training, and making internet access problematic due to weak digital connections [2].

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Slow tourism has been recognized by SNAI as a potential driver of long-run and sustainable developments given the characteristics of the Italian context and the presence of different potential attractions [3, 4]. This new perception of tourism is based on itinerant destinations, through which it is possible to promote the territory and the different proposals present in it. The emergence of slow tourism offers important development scenarios for the Italian inner areas [5, 6], and allows the valorization of that minor real estate heritage no longer in use, such as stations, mills, tollhouses, rural and service buildings, through the implementation of a redevelopment process offering opportunities for new forms of entrepreneurship, work and widespread utility. Given this opportunity, it becomes necessary and strategic to understand how to enhance these strengths, solve current issues and criticalities and allocate potential resources [7].

Within this context the aim of the current contribution is to propose a methodology to support the Decision Makers (DM) in allocating resources for the valorization of minor real estate heritage crossed by slow tourism lines; in detail cycle routs will be considered. The analysis is based on the researches proposed by [8–11] which defined already consistent sets of criteria able to evaluate both the Attractiveness and Vulnerability of inner areas; in addition the FITradeoff method has been applied given its potentials in interacting with the DM and the easy comprehension and visualization of the results. Moreover, considering the slow tourism context and the reuse of abandoned buildings, the presence of multiple values involved and several dimensions to analyze requires the adoption of a multicriteria approach how suggested by [12–15].

The paper is divided into five different sections. After a brief introduction aimed at exploring the decision problem, the methodology applied to rank the buildings selected to be valorized is presented. Section 3 describes the overall approach while the fourth its application and then some conclusions and future perspectives are drawn.

2 FITradeoff Decision Process: Combining Elicitation by Decomposition and Holistic Evaluation

The FITradeoff method (Flexible and Interactive Tradeoff) was developed by [16] to solve multicriteria decision problems with partial information within the scope of the Multiattribute Value Theory (MAVT). This method carries the whole axiomatic structure of the classical tradeoff procedure developed by [17], but improves its applicability for decision makers with easier elicitation questions, since only preference statements are requested from the DMs, instead of declaring indifferent points.

This method is suitable for solving Multicriteria Decision-Model (MCDM) choice problems [16], but also ranking problems [18], sorting problems [19] and portfolio problems [20, 21]. The FITradeoff method works based on partial information obtained by the DM from the declaration of preferences, through an interactive process, and such information is converted into inequalities that act as constraints for linear programming (LP) models that run searching for a recommendation for the DM. Mathematical models change according to the problematic being treated, but the preferences elicitation process is similar for all decision problematics. For the choice problematic, the LP model runs searching for potentially optimal alternatives at each interaction, and the process

works based on a progressive reduction of potentially optimal alternatives until a satisfactory solution for the DM is found [16]. In the ranking problematic, dominance relations between alternatives are tested based on LP models that search for the maximum difference between alternatives global values [18], and a ranking of the alternatives is constructed based on these dominance relations found. In the sorting problematic, the minimum and maximum values of each alternative for the current weights space are obtained through LP models, and then decision rules are applied to allocate alternatives into predefined categories based on those values [19]. The portfolio problematic with FITradeoff has two different approaches; the first one works based on the classical combinatorial approach for solving portfolio problems [21] and the second one works based on a heuristic approach thank ranks alternatives based on their benefit-to-cost ration [20]. In this work, the FITradeoff for ranking problematic is applied.

In the FITradeoff method, the two basic paradigms of preference modeling are combined within the decision process [22]: elicitation by decomposition and holistic evaluation. In the elicitation by decomposition, the decision maker compares elements in the consequences space, considering tradeoffs amongst criteria [17]. This is a cartesian process, from which inequalities that involve criteria scaling constants values are obtained. In the holistic evaluation, the decision maker compares elements in the alternatives space, aided by visualization graphics provided by the FITradeoff decision support system (DSS). Based on holistic judgments made by the DM, inequalities comparing global values of two alternatives are obtained. The information obtained by both types of elicitation are joined to form a space of weights, i.e., a set of possible weights vector compatible with the preference structure of the DM. Then, LP models search for a recommendation for the DM considering the current space of weights which define the consistency and robustness of the result.

The FITradeoff method is operated by a flexible and interactive decision support system available for free at www.cdsid.org.br/fitradeoff. This method has been applied in a wide range of practical applications, such as supplier selection problems [23]; location of health units [24]; ordering special operations of Brazilian Federal Police [25]; energy policy related problems [26, 27]; selection of scheduling rules [28]; selection of agricultural technology packages [29]; selection of strategic information systems [30]. Simulation studies performed by [31] show that the FITradeoff method presents a relatively high convergence speed, in a sense that in 90% of the cases simulated, the subset of potentially optimal alternatives is reduced to up to 8 alternatives after the ranking of criteria scaling constants, considering problems with up to 70 alternatives.

3 Methodology

The methodology of this work is summarized in Fig. 1, it consists mainly of seven phases:

1. The first step consists on defining all stakeholders and experts that will be part of the evaluation for this problem and the identification of the Decision Maker (DM), in charge of taking the final decision;

2. Criteria were then defined based on a deep search on the literature, the availability of information and according to the objective to be achieved, in this specific context according to attractiveness and vulnerability aspects;

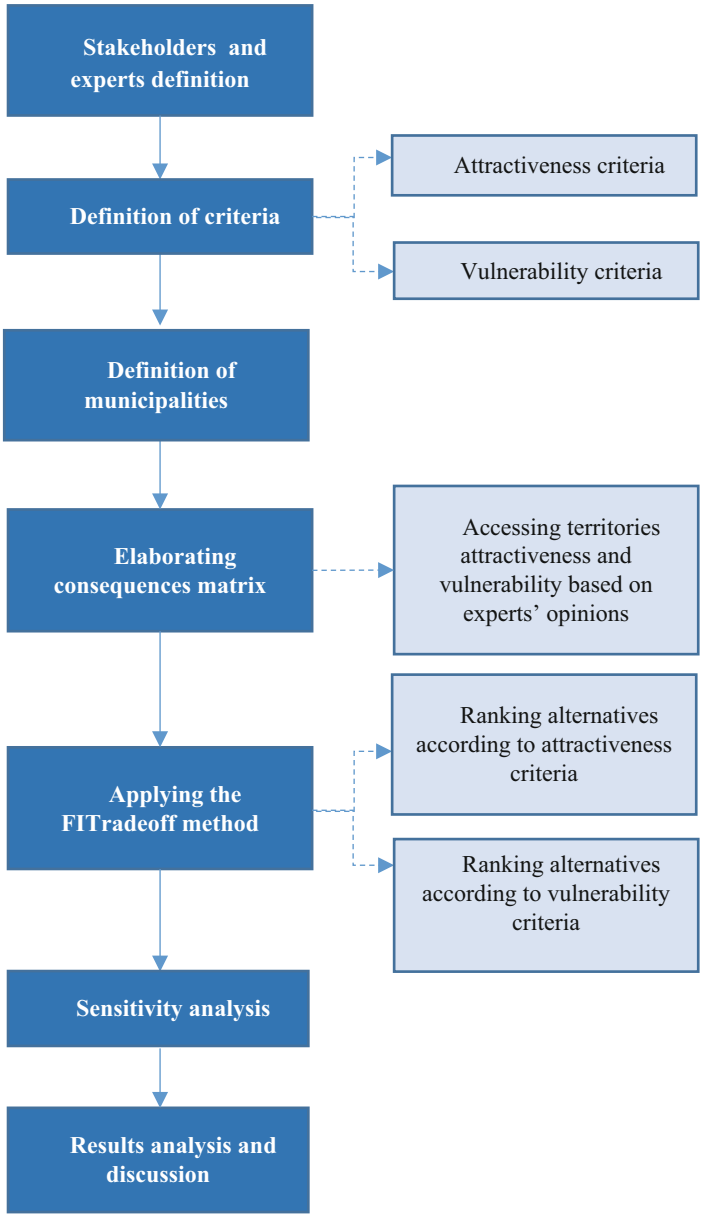

Fig. 1. Methodology Flowchart

3. Then, a set of minor real estate heritage is stablished to be evaluated with respect to the criteria previously identifies;
4. The performance of each alternative in each criterion was then defined based on the consultation of official national website;
5. The FITradeoff method was then applied twice: to rank the buildings according to the attractiveness criteria and according to vulnerability criteria;
6. The sensitivity analysis has been performed to validate the results obtained;
7. Finally, the results were analyzed and discussed in order to draw insightful recommendations and to try to answer to the resource allocation problem.

The approach proposed could be replicated for analyzing other case studies, and phases better specified considering the peculiarities of each context.

4 Application

Given the methodological framework defined, within this context the application will be presented. For what concerns the stakeholders identifications, in order to be consistent and objective within the all evaluation process, groups of experts have been interviewed in the different phases of the methodology. In detail their experience have been requested both in a preliminary phase to understand the decision context and its boundaries and also for the set of criteria validation. Given in fact, the purpose of proceeding by taking a technical decision, as DM in charge of applying the FITradeoff method has been selected an actor belonging to the expert category [32] with experiences in the project appraisal evaluation, cultural heritage valorization and with specific knowledges in the inner areas promotion.

Considering the decision problem consisting in allocating resources with the aim of valorizing minor real estate heritage located in proximity of cycle routs, and starting from the researches developed by [8–11], two different value trees have been identified. Both the attractiveness and the vulnerability of municipalities crossed by the cycle routs VENTO[1] (which connects VENezia to TOrino) have been analyzed. In detail within this context, in order to test the methodologies and investigating homogenous territories, municipalities belonging to the Province of Alessandria and Vercelli (Piedmont Region, Italy) have been selected and more in particular the buildings located in those areas (Fig. 2). The identification of most significant buildings has been guided by a detailed on-site survey and the study of their intrinsic characteristics i.e. the typology, the ownership, the degree of conservation, the dimension and the estimated cost for the recovery. This preliminary analysis allowed to identify a set of eight buildings and their performances have been detected by consulting official geoportal and websites (ISTAT - National Institute of Statistics; Copernicus Atmosphere Monitoring Service; Urban Index – Indicatori per le Politiche Urbane; etc.). Tables 1 and 2 presents respectively the Attractiveness and the Vulnerability performance matrix. A detailed description of the criteria defined has been provided by [8–11].

[1] VENTO was founded in 2010 as part of a multidisciplinary research group working at the Department of Architecture and Urban Studies of the Politecnico di Milano with the aim of analysing the issue of bicycle infrastructure with a tourism function in Italy.

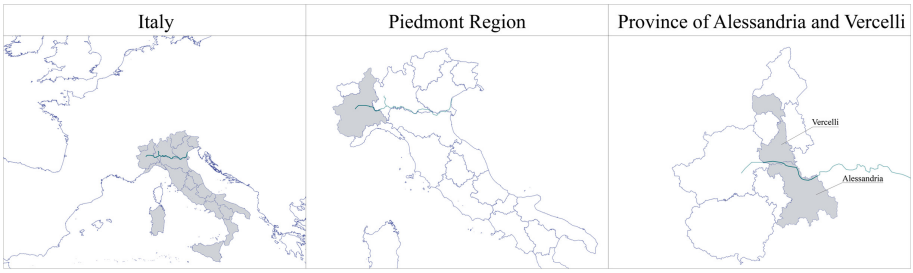

Fig. 2. Location of the case study

Table 1. Attractiveness performance matrix

Objective	Criteria	U.M	Building 1	Building 2	Building 3	Building 4	Building 5	Building 6	Building 7	Building 8
Attractiveness	**Parks and protected areas**	**meter**	0	0	322	34	37	72	170	1460
	Natural areas	**meter**	0	0	322	34	37	310	170	1460
	Cultural heritage	**n° within 5 km**	23	13	100	10	10	24	12	15
	Landscape	**n° within 5 km**	1	0	0	2	2	0	0	0
	Hospitality	**meter**	2200	1700	1600	1800	1200	1100	4800	3500
	High quality wine - yards	**meter**	800	20	0	3000	840	0	0	780
	Connectivity	**meter**	300	70	0	0	0	0	95	1900
	Interchange nodes	**meter**	1800	2600	2400	5400	5200	2100	8800	7800

4.1 DM Interaction and FITradeoff Method Application

Once the consequences have been detected, the elicitation of the DM's preferences can be processed in order to rank the buildings according to the two value trees previously presented. The interview started by presenting the overall purpose of the analysis and the meaning of the different criteria involved. The DM has been selected since confident with the problem to be faced, the methodology to be applied and also with the terminology used to explain the phases. After this introduction, the interaction proceeded by asking to rank the criteria scaling constants by the support of the pairwise comparison.

The elicitation started with the criteria belonging to the Attractiveness dimension and then the judgment between two potential consequences as required by the methodology. The first elicitation process resulted in the following preference: 1. Interchange nodes; 2. Connectivity; 3. Hospitality; 4. Cultural Heritage; 5. High quality wine – yards; 6. Parks and protected areas; 7. Natural areas; 8. Landscape, and it has been justified by the high degree of importance of a place to be accessible in order to be attractive. After this interaction already a ranking of the eight building has been found divided

Table 2. Vulnerability performance matrix

Objective	Criteria	U.M	Building 1	Building 2	Building 3	Building 4	Building 5	Building 6	Building 7	Building 8
Vulnerability	**Per capita income**	**€/freq**	18317,2	18921	21179,6	19855,3	16990,4	19981,6	19015	0
	Unemployment rate	**%**	7,3	9,22	10,71	8,98	11,97	11,51	11,41	2,91
	Local units of the manufacturing sector	**%**	4	5	257	7	4	752	23	0
	Industrial concentration in the manufacturing sector	**%**	0,14	0,18	0,2	0,33	0,18	0,58	0,27	0,06
	Percentage of Utilized Agricultural Area (UAA) out of the total	**%**	92,8	90,5	89	73,6	88,2	77,2	72,5	92,4
	Digital divides from fixed and mobile networks	**%**	0	14,6	10,8	45,1	95,3	2,7	3,3	90,5
	1st Grade school failure rate	**%**	10,67	12,57	6,92	8,94	8,73	7,58	9,74	12,16
	Old age index	**% Ratio**	231,5	261,3	225,8	208,5	280,4	220,8	196,4	190,2
	Population density	**inhab/km2**	51,76	85,34	403,8	49,75	85,81	405,63	60,67	53,05
	Foreign population	**%**	54	2854	17	66	102	34	4	25
	Average ten-year rate of resident population's change	**%**	0,6	-1,5	-5,4	3,9	-4,3	-4,1	1	7,6
	Accessibility index to urban centers (road)	**(1–5)**	2	3	3	2	2	2	1	2
	Average annual PM10 concentration	**µg/m^3**	25,1	24,6	24,9	25,1	25,2	25	24,8	24,5
	Drinking water per capita, fed into the municipal network	**m3/inhab/yr**	71,7	65,7	91,3	47,5	43,4	75,7	52,8	54,6
	Estimated building density	**m3/km2**	21077,9	26903,7	97130,1	17146,2	37073,6	91121,6	23156,7	0

(*continued*)

Table 2. (*continued*)

Objective	Criteria	U.M	Building 1	Building 2	Building 3	Building 4	Building 5	Building 6	Building 7	Building 8
	Non-use rate of buildings	**%**	12,3	1,5	4,9	1,1	6,2	5	6,7	0
	Per capita waste production	**kg**	246,5	324,8	495,6	287,8	324,5	257,8	257,8	257,8
	Soil consumed per capita	**m2/inhab**	1501	1289,5	397,2	1084,6	695	291,4	762,6	1453,2
	Seismic hazard	**Ag**	0,037	0,037	0,039	0,041	0,044	0,051	0,058	0,066

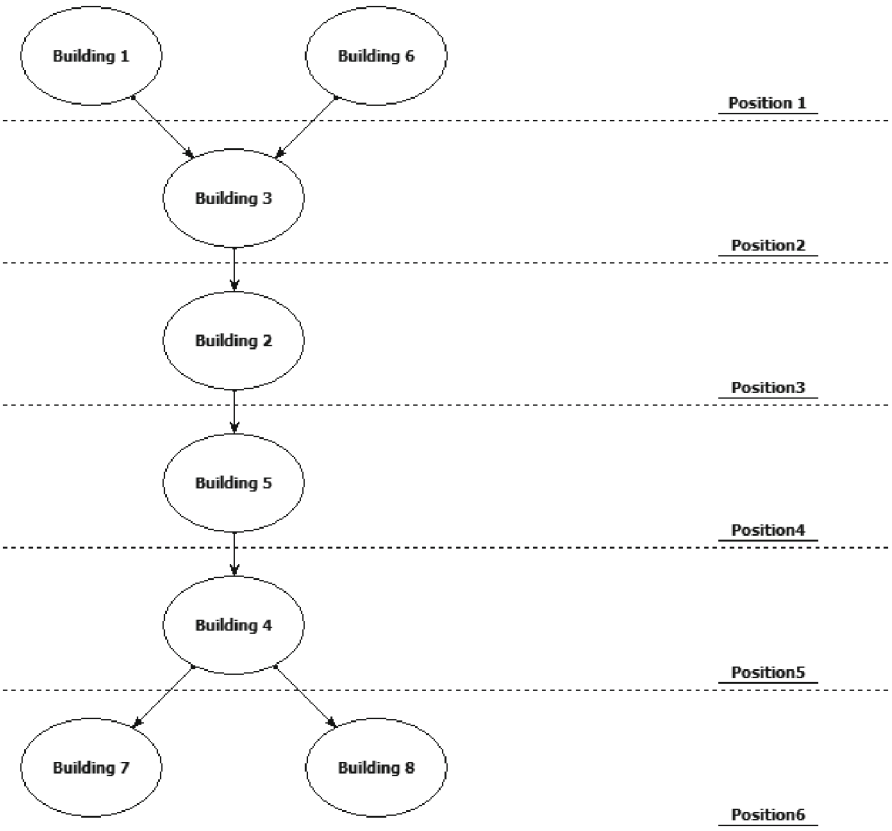

Fig. 3. Attractiveness overall result

in three levels, but the DM was not satisfied with the results and decided to proceed continuing the elicitation by decomposition which allows to compare and decide among two consequences. After fifteen questions the DM decided to stop the interaction and to visualize the results, in fact, for the final ranking six levels have been obtained and Building 1 and 6 were tied for first place (Fig. 3). Considering the overall results and

the partial ones visualized according to the performances got for the different criteria (Fig. 4) and provided by the holistic evaluations, the DM decided that Building 6 as an average was the most attractive by considering the set of criteria defined.

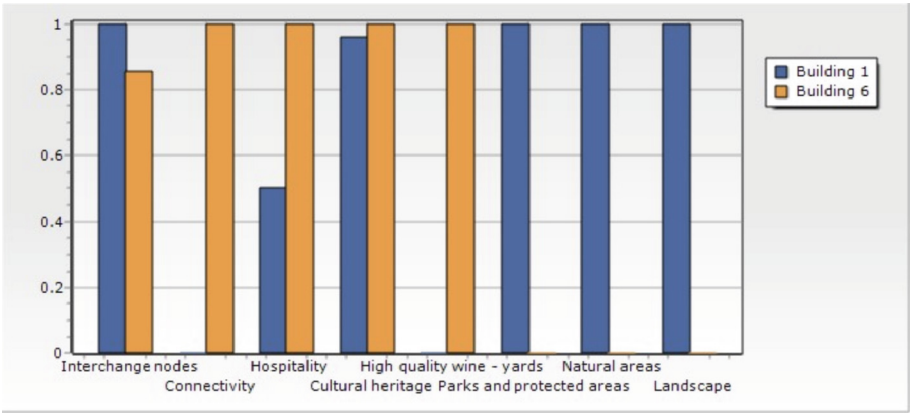

Fig. 4. Attractiveness partial results

After the elicitation developed for the attractiveness, the same process has been carried out for the vulnerability dimension resulting in: 1. Seismic hazard; 2. 1st Grade school failure rate; 3. Digital divides from fixed and mobile networks; 4. Accessibility index to urban centers (road); 5. Percentage of Utilized Agricultural Area (UAA) out of the total; 6. Drinking water per capita, fed into the municipal network; 7. Soil consumed per capita; 8. Average ten-year rate of resident population's change; 9. Population density; 10. Old age index; 11. Local units of the manufacturing sector; 12. Unemployment rate; 13. Per capita income; 14. Foreign population; 15. Non-use rate of buildings; 16. Industrial concentration in the manufacturing sector; 17. Average annual PM10 concentration; 18. Per capita waste production; 19. Estimated building density, and it has been justified by the presence of features that cannot be modified or improved. Only one level has been found after the first interaction and the DM decided to go on with the elicitation by decomposition. After twenty-one answers the DM decided to stop the interview given the high effort and the time required; five levels have been obtained and Building 1, 2 and 3 were tied for first place (Fig. 5). Also in this case the DM decided to proceed by visualizing the partial results according to the holistic evaluation and considering the different graphs which the method presents (Fig. 6), Building 3 has been judged as the asset located in the least vulnerable areas.

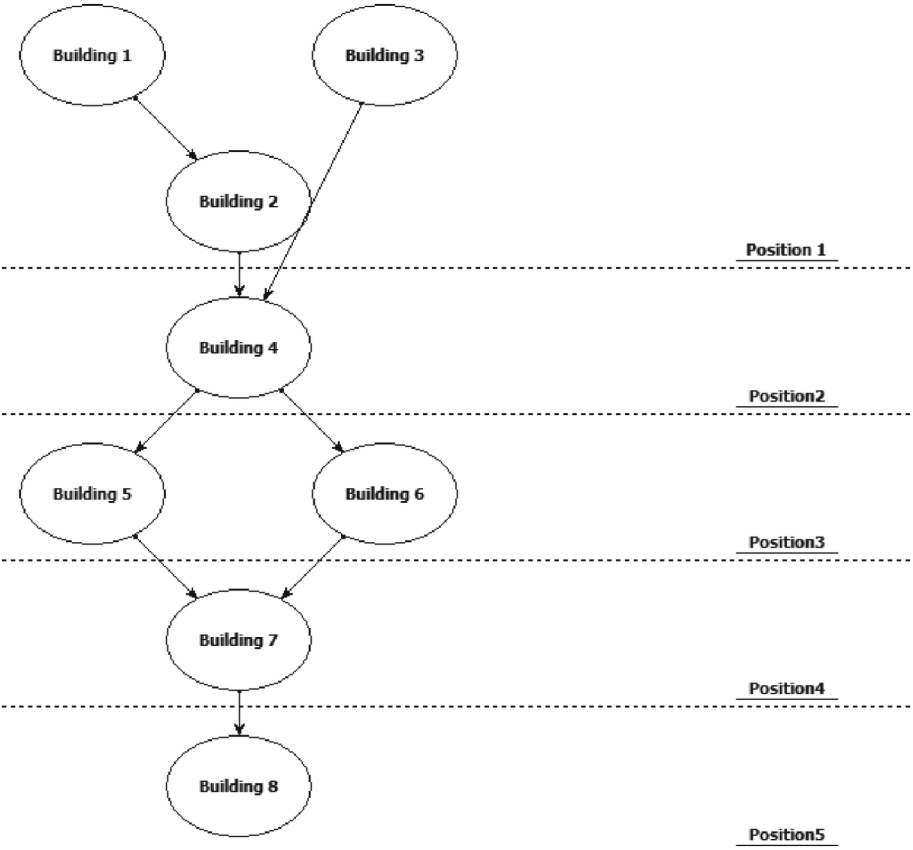

Fig. 5. Vulnerability overall result

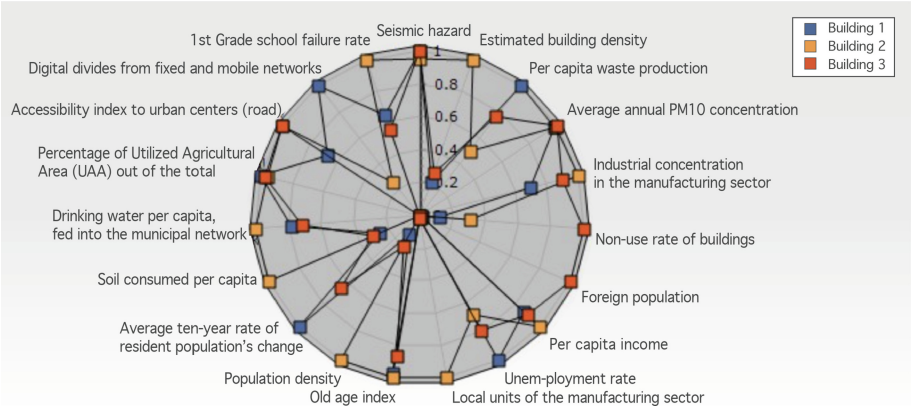

Fig. 6. Vulnerability partial result

4.2 Discussion of the Results

Given the differences in the results obtained, the DM decided to visualize for both the dimensions the sensitivity analysis by considering 10% of variation to the criteria involved to understand the stability of the decision and validate it. Figures 7 and 8 presents respectively the sensitivity analysis performed for the Attractiveness and for the Vulnerability.

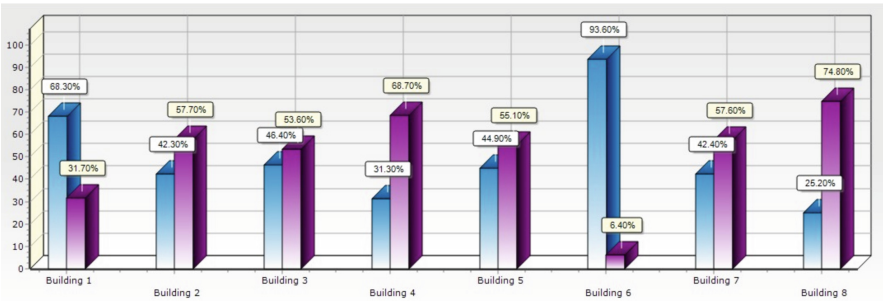

Fig. 7. Attractiveness sensitivity analysis

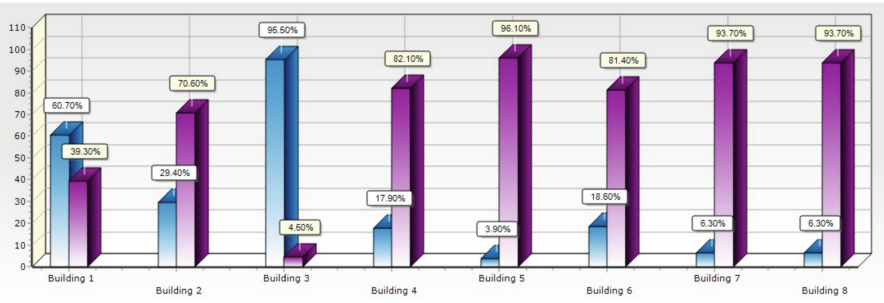

Fig. 8. Vulnerability sensitivity analysis

Both the figures show how the results obtained are not stable and only by varying the consequences space for the criteria involved of 10% the changes are quite sensitive.

In fact, after this visualization the DM was not very confident in taking a final decision but analyzing better together Figs. 7 and 8, found out how the most stable alternative, which keeps a satisfying overall performance with and without the 10% of variation and ranked in both the graph in the first positions is Building 1. In fact, while a high performance obtained for the Attractiveness correspond to the location of the building in an area very attractive, for the vulnerability the result has to be read in reverse, a high performance corresponds to a territory that is not very vulnerable and therefore very resilient. This further explanation allows to better understand how Building 1 classifies in the top ranks of both Attractiveness and Vulnerability.

5 Conclusions

The research proposed aims at supporting the DM in taking more conscious decision about the allocation of resources for the valorization of minor real estate heritage and promoting the slow tourism in inner areas. Marginal territories, in constant depopulation, call for policies and new methodologies capable of implementing authentic tourism oriented towards sustainable development for territories and local communities. This does not mean replicating the economies that have worked in the most attractive territories and urban contexts, but rather reflecting on transformation scenarios starting from the least participant populations and local specificities, thus from unused resources [33]. The criteria involved in the decision process have been selected with the idea of catching the peculiarities of those territories and trying to exploit them. In fact, analyzing both the strengths and criticalities of the same context helps in having awareness and in taking coherent decisions.

The extra effort charged by the DM in answering to the second interview consisting in the Vulnerability dimension has been strongly affected by the number of criteria involved. This criticality could be overcome by reducing the number and trying to check if double counting are present.

The study could be further implemented and validated by the involvement of different categories of stakeholders [34], in particular political and bureaucratic in order to have a real impact on public policies and strengthen the necessity of robust methodologies for allocating public resources, especially where there is a limited amount of resources available.

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