



Original article

Valorization of cultural heritage and land take reduction: an urban compensation model for the replacement of unsuitable buildings in an Italian UNESCO site

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ABSTRACT

The enhancement of historical, artistic and cultural assets is a topic of significant interest in the international and national context within the policies able to reduce the land take. However, it often happens that the full conservation and enhancement of the cultural heritage site is hindered by recently built buildings that are inconsistent with the valuable characteristics of the surrounding urban environment. Aim of the work is to define and implement an innovative compensation-based model to enable the demolition and reconstruction of unsuitable buildings that prevent the enhancement of historic city centers. It represents a decision support system for the Public Administration in the determination of the building rights to be transferred to the Private Entrepreneur involved, by ensuring financial convenience, environmental purposes and overall positive public effects. The analysis of the results obtained by applying the compensation-based model to the city of Alberobello, a UNESCO Italian heritage site, demonstrates its usefulness, efficiency and flexibility.

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1. Introduction

The cultural heritage has an important role in the regeneration of cities and landscape aimed at the achievement of the environmental quality improvements promoted by international and national regulatory programs. It is considered as a non-renewable, irreplaceable source and a common good, therefore its conservation is of well recognized importance [1–3]. Valorizing properties of high historic and artistic values (both public and private ones) means preserving it and giving it back to the community through its well conservation ([4]; Morano et al., [5]; [6–8]), by ensuring also a reduction of the land take extension. In fact, an efficient valorization of existing cultural heritage assets must be able to: (i) ensure the history's transfer that is represented for the present and future generations, (ii) reduce the urban decay and (iii) avoid further natural soil consumption with new buildings [9,10].

Despite the unquestionable strategic importance of cultural heritage to achieve the objectives of sustainable development the financial sustainability of cultural heritage conservation processes is still a critical point. In Europe, the debate on the recovery of the

historic centers has been developed, over the years, around the balance between conservation and transformation needs in order to meet the new demands of the societies. In the field of urban planning, flexible and consensual mechanisms that catch the interest of private's involvement in the redevelopment and regeneration of the historic urban landscape, has been spread [11]. In the Italian context this appear most of the time a critical issue, due to the unbalanced existing conditions that consists of a consistent amount of valuable properties available - to be renovated or enhanced - and limited financial public resources. For these reasons the total or partial abandonment and degradation often occurs.

By examining the literature review on the topic addressed, urban compensation schemes appear to be employed for the public acquisition of land, as an alternative to the compulsory purchase [12]. Nowadays under the name of “non-financial compensation” the urban compensation models exist in the literature applied to a wide range of planning solutions in which the public subject compensates the private one with development capacity instead of monetary reward [13,14]. On the international level, an interesting case is provided by the “Space for Space” program in the Netherlands [15]. The aim of the project was to achieve a qualitatively better arrangement between urban and rural areas by means of demolishing the existent pig stocks. An appropriate non-financial compensation scheme has been used by obtaining an urban area

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with overall higher quality. Another example is the case of the Lake Tahoe area – a environmentally sensitive zones with unsuitable properties – that required the demolition by transferring the related buildings rights. The program creates a local market for development rights that can also be transferred between different administrative units, according to the future developments of each community [16]. In Valencia (Spain) a non-financial compensation instrument was used in the redevelopment of the Francia Avenue's former industrial area. It was redeveloped for residential and commercial purposes and 170 different buildings have been demolished. In this case the land readjustment contemplated the possibility to the landowners for selling their property to the municipality or the development agent, or receiving development rights [17]. In the city of Malibu (America) a non-financial system was successfully implemented to ensure that no net increase in density would occur within the environmentally sensitive areas. This is accomplished by retiring rights to develop on certain other parcels in the Santa Monica Mountains Area coastal zone from private property owners. The successful reduction in development increases the overall quality of the area by preserving the nature [18].

In Italy the application of urban compensation models is still limited but often focused on asset's regeneration purposes. For example, in Umbria the study of Lazzarotti [19] analyzes the compensation of owners for the costs paid for the recovery of public and private historic heritage by granting development rights bonus to be developed outside the perimeter of the historic center has been carried out. In Sardinia the application of the urban compensation tool with the granting of buildings rights in order to encourage urban regeneration projects that involve the replacement of unsuitable properties within historical urban landscape, has highlighted the usefulness of the tool. Also, the Veneto recognizes a construction bonus for the demolition of incongruous buildings, the elimination of the elements of degradation, the improvement of urban, architectural and environmental quality [20].

The transfer of development rights among different territorial areas is not uniquely achievable and depends by the socio-economic and environmental features of the goods to be exchanged [21]. From a methodological point of view, the Break-Even Analysis (BEA) is a useful tool to assist these urban issues. Della Spina and Calabrò [22] adopt the BEA to support the public decision to identify the best appropriate function for the conservation and reuse of a historic building. In general, BEA has been often applied in the urban regeneration's feasibility assessment such as the case of the brownfield redevelopment [23], the social housing extensions within sustainable urban investment [24], the identification of the type of entity to be entrusted with the management of architectural heritage [25], the urban project's scenario analysis [26] or for indirectly assessing the environmental quality improvement [27]. Other applications of the BEA regard: the identification of functions or properties to produce to maximize the convenience of the initiative; the size of the quantity of product to be realized and sold; the definition of the product selling price and policy analysis to evaluate the effects on sales plan; the impact of the financial structure's costs items of the project on the feasibility of it; the evaluation of the consequences caused by changing products demand [28,29]. The main advantages of the BEA compared to other financial assessment tools are the simplicity of the mathematical functions and the structure, the possibility to provide an *ex-ante* evaluation by avoiding the uncertainty of the time effects on the financial resources in the analysis and, moreover, it can be a decision support system for both public and private subjects.

The paper is structured as follows: Section 2 provides for the aim; Section 3 explains the model; Section 4 describes the case study and results; Section 5 reports the conclusions and future developments of the work.

2. Research aim

The present research is part of the framework outlined and intends to define an innovative compensation-based evaluation model able to support the determination of buildings rights that guarantee: the financial conveniences of public and private subjects involved into cultural enhancement interventions; the reduction of the natural soil consumption. Through the principles of the BEA, pertaining to the Cost Volume Profit Analysis, in the context of urban compensation schemes, the Public Administration (PA) can be able to recognize to the Private Entrepreneur (PE) the adequate building rights that guarantee his financial convenience for the need to proceed to the enhancement of the historic center of Alberobello, an important Italian UNESCO site located in the Apulia region, for removing an unsuitable building with a PPP intervention. It is important to note that the innovation of the work pertains to: the application of urban compensation instead of classical expensive expropriation procedure; the use of a quickly and simple financial tool like the BEA rather than the generally laborious monetary and uncertain balance for enhancement; the multi-scenarios analysis; the support of land use transformations monitoring for the sustainable protection of cultural heritage as a driver of social cohesion and jobs creation.

3. Material and methods

Urban planning compensation is based on the equivalence, in terms of value, between the resources to be acquired, for public use, and the ones that are offered in exchange. These equivalences are determined by the measures arranged by the individual administrations, but the achievement of a shared hypothesis represents the delicate step. In fact, it is difficult to identify a unique equivalence model since it can be different according to reference contexts available resources, objectives and interests of the subjects involved, therefore the application schemes can be numerous. In Fig. 1 are illustrated the general schemes of possible urban compensation-based models. In the present research, one specifically chosen on the basis of the characteristics of the case study is applied. The compensation tool is developed around two types of resources, those to give or that can be requested from property owners and entrepreneurs, and those that, to owners and entrepreneurs, the PA can give in compensation.

The logic of the compensation tool is: each type of resource to give corresponds to one (or more) to be balanced in terms of equivalent value. To ensure the success of the operation, it is essential to consider the economic value of the goods to be exchanged. Buildings to be sold for public use are assessed with their market value, as also land. The model that is often preferred by the PA is the transfer of building rights in exchange for the sale by private subjects of land, properties or the execution of public works. In fact, there is no payment for this, thus fill the lack or scarcities of public financial resources. This model can be schematized as follows:

- i. Detailed knowledge of the unsuitable building to be acquired from an urban-legal point of view and in physical, quantitative and qualitative terms;
- ii. Legal and urban planning (extension, buildability, eligible uses, coverage ratio, etc.) characterization of the area where the building rights to be recognized to the PE has to be relocated;
- iii. Study of the local real estate market in which the building to be demolished and also the area on which the equivalent building rights will be used, are located;
- iv. Assessment of the market value of the unsuitable building and the eventual costs for the rearrangement of the vacant area by the PE, if provided by the agreements;

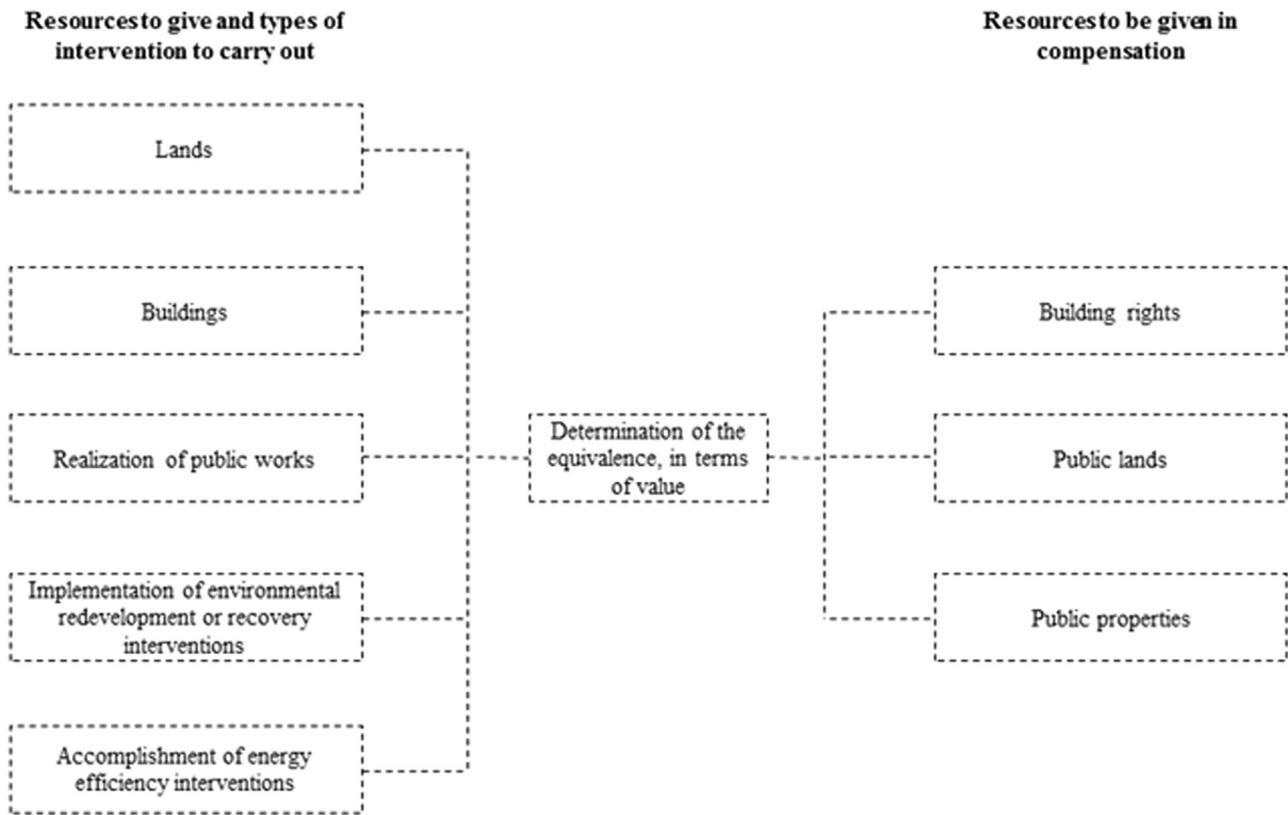


Fig. 1. General schemes of possible compensation-based models.

- v. Analysis of ownership of the landing area and appraisal of its market value;
- vi. Determination of building rights equivalent to the market value of the property sold for public use and any volume increase to compensate for the possible cost of demolition or of rearranging the area (if provided by the agreements).

The market value of the property to be acquired or of the building rights to be sold will be calculated on the basis of the existent conditions at the time of the agreement. The market value of the unsuitable building is linked to how the real estate market appreciates it. The building credit to be determined for the compensation can be generally relocated on:

- i. same owner's land. In this case, it is appropriate to evaluate the market value of the land to be sold and the possible increase of it that the landing area acquires after the recognized buildings rights realizations;
- ii. public area that is therefore sold to a PE. In this case it is appropriate to evaluate the market value of both the landing area and the rights;
- iii. areas belonging to third parties.

The General Regulatory Plan (GRP) allowed functions, the location of the landing area - peripheral or central -, the quality of the constructions, as well as the type of building, the distribution of spaces and the technological solutions adopted, are all parameters that affect the value of the building rights, making it not uniquely determinable. For the purposes of the work, the BEA is particularly efficient because can led to objective optimal solutions analysis in a quickly and simple way, without high-profile skills, by only knowing the main costs items of the PPP intervention [30].



Fig. 2. Sovereign Trullo of Alberobello city.

4. Calculation for Alberobello city, an Italian UNESCO site

Alberobello is a city of the Apulia region (Southern Italy) known worldwide for its characteristic historical housing units, the so-called "Trulli", a type of conical construction in traditional dry stone that exist only in this region. Since the 1996, the Alberobello city became UNESCO World Heritage Site, having a whole historic center entirely built with "Trulli". One of the largest "Trulli" in Alberobello, overlooking the "Sacramento" square, is fourteen meters high and is called "Sovereign Trullo" for its bigger dimensions with the surrounding units (Fig. 2).

Originally used for residential purposes, these buildings have been progressively abandoned or transformed into touristic and



Fig. 3. Main facade of the unsuitable building and the near “Trulli”.



Fig. 4. Unsuitable property site.



Fig. 5. Unsuitable building’s facade.

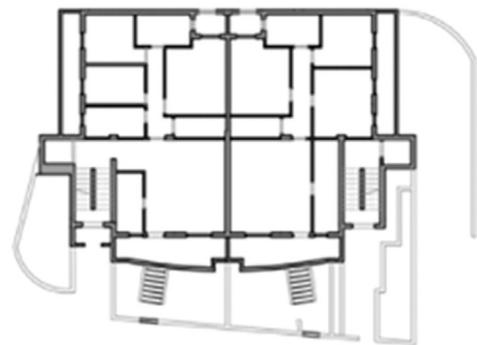
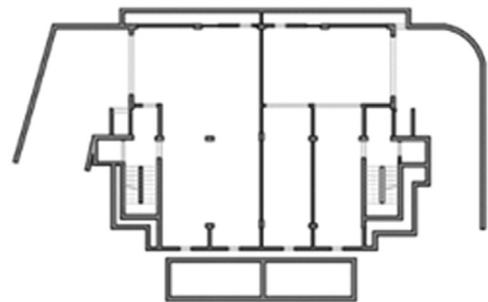


Fig. 6. Basement, mezzanine, first floor plans.

commercial activities. Recently in this area, a new residential building appears overwhelmingly (Fig. 3), characterized by three levels with economic finishes of the residential type, surrounded by a related area both paved and uncultivated (Figs. 4 and 5).

It has a total volume of 2250 m³ and a total commercial surface equal to 639 m² with the distributive spaces as represented in Fig. 6.

It is a source of degradation for the historic center, and for this reason the PA wants to remove it in order to preserve the cultural value of the historic center, according to the regional Law no.18/2019.

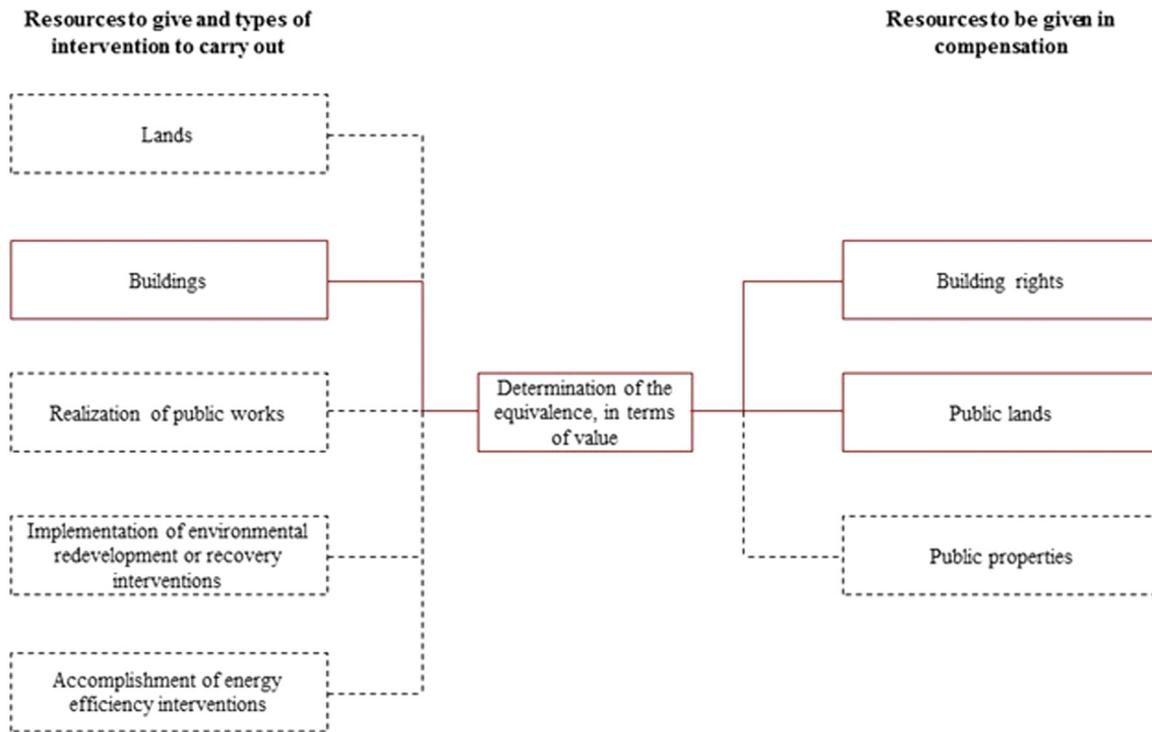


Fig. 7. Compensation model of the case study (red).

4.1. Application of the proposed urban compensation model

In the case study, the issue to be addressed is one of the main application fields of non-financial compensation-based model (as seen in Section 1). The aim is to remove the unsuitable building by compensating the PE involved with building rights to relocate on more appropriate urban land plot in order to facilitate the enhancement of the historic site. For these reasons, the BEA is utilized for determining the break-even point of the square meters of gross floor surface (GFS) which brings to the balanced budget.

Two parties are considered, a PE who has the task of dealing operationally with the demolition of the unsuitable building, and the PA that transfers building rights and public land to the private subject such as (i) to guarantee the financial convenience of the initiative, (ii) to reduce the natural land take, (iii) to preserve the historical-artistic value of the area of the monumental district surrounding the intervention's zone. Therefore, according to the general scheme of compensation-based models represented in Fig. 1, the following Fig. 7 shows the specific-related urban compensation model applied to the case study of Alberobello city.

Specifically, in order to evaluate different solutions for led to the PA the possibility to choose the most interesting, the analysis of the feasibility of two different scenarios is envisaged: the first consists of the PE who deals with buying and demolishing the building, landfill and then dispose of the debris; the second has, in addition to the operations of first scenario, also the for the PE the rearrangement of the resulting area of the demolished property. The landing area on which it is assumed that the rights that can be granted in exchange to a PE can be relocated, is of the PA. This area of the urban center is affected by a Rehabilitation and Renovation Recovery Plan, with a maximum building index of 5 m³/m². The eligible uses, in accordance with the Technical Implementation Standards (TIS) of the GRP, are residential (or similar) and recreational - cultural types. The identified land plot is about 250 m from the unsuitable building' site, it is free and has an area of 4,396 m². However, in accordance with the GRP's provisions

for it, there are restrictions on new construction, because it is in the historic center. Therefore, it is hypothesized the possibility for the PA to deal with a variant that affects only part of the landing area considered, making it buildable, such that on this portion the building rights can be relocated. The choice is justified by the enhancement's advantages that would derive to the PA by removing the unsuitable building. The Real Estate Market Observatory (REMO) zones defined for Alberobello city by the Revenue Agency in the 2019 are analyzed. They identify similar territorial areas from the point of view of socio-economic, environmental and market conditions which lead in a homogeneous way to the formation of the property values. Every six month the REMO publishes the maximum and minimum ranges of the real estate quotations, and this is main reference for all the operators. In this case, the building falls within the market microzone no. 1 with zone code B1 (central), characterized by residential and economic building typology, i.e. with low-cost materials and finishes.

Considering the discrete construction features and well-made finishes, the minimum (940 €/m²) and maximum (1400 €/m²) market values of €/m² referring to civil dwellings are considered. The landing area of the building rights is within the microzone no. 2 with zone code C1 (semi-central), residential and civil typology, with buildings of good quality are detected

For the purpose of the work, it is necessary to determine the market value of the property itself. Therefore, in accordance with Annex C of the Presidential Decree no. 138 of 23/03/1998 "Technical Rules for Determining the Cadastral Area of Real Estate Units for Ordinary Use", the total commercial area is determined in the amount of 638.50 m². On the basis of the REMO quotations relating to the second half of 2019 for residential use and economic building type, the average market value of 1,170 €/m² is established (average between the maximum quotation and the minimum one of B1 zone). The market value (Vm) of the unsuitable property is equal to:

$$Vm = commercial\ surface \cdot average\ unit\ market\ value = 638.50m^2 \cdot 1,170\Delta/m^2 = 747,045\Delta$$

Table 1
Data for the calculation of the total cost for demolition operations.

COST ITEM	UNIT PRICE	QUANTITY
Demolition	29.90 €/ m ³	2,250 m ³
Transport rubble	6.2 €/ m ³	280.36 m ³
Disposal charges	3.8 €/quintals	3,828.1 quintals
Total cost of demolition operations	83,560 €	

For the assessment of the demolition cost, it is essential to consider the cost of the demolition itself, the transport of the rubble to the landfill and the charges for the disposal of them. This cost assessment is carried out using the regional price list of public works - year 2019 - of the Apulia region as reported in Table 1.

The rearrangement of the resulting area has the aim of obtaining urban green space within the monumental historic center that increase the environmental quality, for this purpose a green redevelopment is proposed. The PE, therefore, after the removal and disposal of the unsuitable building's material, has to rearrange the area. According to the Price List of the Building Types (2019) developed by the College of Engineers and Architects of Milan the total rearrangement cost (C_r) is:

$$C_r = 1,030m^2 \cdot 33\Delta/m^2 = 33,990\text{€}$$

The assessment of the market value of the area, given its intrinsic non-building capacity, is carried out with a survey at the local real estate agencies. This area is comparable, in terms of characteristics and attractiveness, with the adjacent ones belonging to zone B of the GRP. Therefore, considering a maximum building index of 5 m³/m², the unit market value of the landing area can be quantified in 250 €/m². In accordance with the GRP, single-family houses on two floors with good constructive and distributive characteristics and well-made finishes can be realized.

In the basic condition for which the transaction takes place in a short period of time such that it does not affect the evaluation of the financial items, and the total production costs and revenues have a linear trend, the BEA considers:

- The amount of building product that is expected to be made and sold (q);
- The total costs (C_t), including the fixed costs (C_f) and the variable ones (C_v), the latter calculated as the product of the unit variable cost (C_{vu}) and the quantity (q);
- The total revenues (R_t), calculated as the product between the unit price (p_u) and the quantity (q);
- The financial convenience of the initiative, in terms of total profit (P_t).

It is possible to determine the total profit of the initiative by using the mentioned parameters related together by Eq. (1):

$$P_t = R_t - C_t = R_t - (C_f + C_v) = p_u \cdot q - C_{vu} \cdot q - C_f \tag{1}$$

The amount of the building rights can therefore be derived from the breakeven point (q*) of the initiative, which can be determined from the previous relationship (Eq. (1)), imposing the condition of annulment of the total profit and isolating the quantity (q). Therefore, Eq. (2) is obtained:

$$q^* = C_f / (p_u - C_{vu}) \tag{2}$$

Eq. (2) identifies the building index to be recognized to the PE: if q* consists of square meters of GFS which brings to the balanced budget, considering that the territorial building index (I_{te}) is equal to the ratio between the GFS that can be built and the area of the territorial surface to be sold (S_t), Eq. (3) can be derived:

$$I_{te} = GFS/S_t = (q^*)/S_t \tag{3}$$

Table 2
Financial data used to determine the budget of the PE.

COST ITEM	UNITS
Demolition	29.90 €/m ³
Land rearrangement	33 €/m ²
Realization of: Residential buildings	750 €/m ²
Private buildings	120.71 €/m ²
Private parkings	39.40 €/m ²
Private green spaces	300.38 €/m ²
Sidewalks and streets	125.78 €/m ²
Private facilities	
REVENUES	UNITS
Residential units sale with private parking	1,250 €/m ²

Specifically, two scenarios are considered:

- (1) the entrepreneur has to purchase the building, demolish it, transport and disposal the rubble. The building rights granted must be able to compensate all these operations' costs. In accordance with the L.R. no.21/2008, the hypothesis of a 35% increase in volume is envisaged to encourage interventions;
- (2) the entrepreneur has to purchase the building, demolish it, transport and disposal the rubble and rearrange the area returned to public use. In exchange, the PE will be granted for this and also in this case a 35% volumetric increase is expected to incentivize the operation.

The financial information useful for simulating the balance sheet of the PE is reported in parametric form in Table 2.

The application of Table 2 items allows to obtain the "summary" of the financial balance sheet of the PE initiative (Table 3).

For the application of the BEA it is necessary to reorganize the cost and revenue items of the financial balance sheet of the PE into "fixed" and "variable" components, as shown in Table 4.

The expenses that do not change according to the GFS to realize belong to the fixed items. The variable ones include the amounts that depend on the GFS to realize. Technical and general expenses and financial charges are to be considered semi-fixed items since derive in part from fixed items and in part from variable ones.

5. Results

The amount of building product (q*) that the PE has to create to bring the balance of the operation can be obtained using Eq. (2):

- 1) Scenario 1: $q^* = 981,708 \text{ €} / (1250 \text{ €/m}^2 - 999.73 \text{ €/m}^2) = 3922 \text{ m}^2$
- 2) Scenario 2: $q^* = 1,015,698 \text{ €} / (1250 \text{ €/m}^2 - 999.73 \text{ €/m}^2) = 4058 \text{ m}^2$

Considering a volume increase of 35% for incentivizing the PE, each scenario is characterized as described in Table 5 both scenarios show a final building index less than the maximum allowed by the TIS of Alberobello and the guarantee of the financial convenience. Thus the PA, according to its land saving and enhancement objectives can choose to: (i) prefer the scenario 1 for reducing the environmental impact of the landing area, or (ii) favor the scenario 2 for giving a new urban green space for replacing the unsuitable building.

Table 3
Summary of the PE's financial balance sheet.

COSTS	UNIT COST/PERCENTUAL INCIDENCE	QUANTITY
Purchase of unsuitable building	1,170 €/m ²	639 m ²
Registration, hypothecary and cadastral fees (ex Law no.58/2019)	200 €	3
SUBTOTAL A		
URBANIZATION FEES		
SUBTOTAL B		
REARRANGEMENT		
Demolition	29.90 €/m ³	2,250 m ³
Land rearrangement	33 €/m ²	1,030 m ²
SUBTOTAL C		
CONSTRUCTION		
Residential units	750 €/m ²	m ² of residential GFS
Private parking	120.71 €/m ²	250 m ²
Private green spaces	39.40 €/m ²	150 m ²
Sidewalks and street	300.38 €/m ²	103 m ²
Private facilities	125.78 €/m ²	132 m ²
SUBTOTAL D		
General and technical fees (SUBTOTAL A+B+C+D)	9%	SUBTOTAL D
FINANCIAL CHARGES	7%	SUBTOTAL A+B+C+D
NORMAL PROFIT	10%	TOTAL REVENUES
TOTAL INVESTMENT COSTS		
REVENUES	UNIT PRICE	QUANTITY
Residential units sale	1,250 €/m ²	m ² of residential GFS

Table 4
Fixed and variable items of the balance sheet.

FIXED COSTS	
Purchase of unsuitable building	747,630 €
Demolition	29.90 €/m ³
Registration, hypothecary and cadastral fees (ex Law no.58/2019)	600 €
Realization of: Private parking	30,178 €
Private green spaces	5,910 €
Sidewalks and streets	30,939 €
Private facilities	16,603 €
General and technical fees (fixed share)	7,527 €
Financial charges (fixed share)	58,757 €
TOTAL SCENARIO 1	981,708 €
TOTAL SCENARIO 2	(981,708 € + Land Reclamation) = 1,015,698 €
RESIDENTIAL UNIT VARIABLE COSTS	
Normal profit of the real estate promoter	125 €/m ²
General and technical fees (variable share)	67.50 €/m ²
Financial charges (variable share)	57.23 €/m ²
Realization	750 €/m ²
TOTAL	999.73 €
UNIT REVENUES	
Sale of residential units	1,250.00 €/m²

6. Conclusions

The enhancement of the historical and cultural heritage is often hindered by the presence of unsuitable buildings that need to be demolished and replaced with careful assessment procedures., and at the same time guaranteeing reduced land take.

The work deals with the mentioned issues with the aim of defining and implementing an evaluation compensation-based model able to support the decision-making process of PPP urban interventions of historic center's enhancement. With reference to a PPP intervention aimed at removing an unsuitable building of the historic center of Alberobello city, a UNESCO heritage site, the pro-

posed model has allowed to verify the financial feasibility of two different scenarios, each of them characterized by different PE's operations and environmental quality level. The work is consistent with the dictates of the Regional Law no.18/2019 "Rules on equalization, urban compensation and extraordinary contribution for the reduction of land consumption and various provisions", that encourages the use of equalization-compensatory models to attract private resources and carry out efficient redevelopments. Moreover, the proposed model can be useful for supporting the PE and PA during the negotiations phases of PPP urban interventions aimed at

Table 5
Main parameters of the two scenarios.

Scenario	q*(m ²)	q* with 35% volumetric increase(m ²)	break-even volume with 35%volumetric increase (m ³)	building index (m ³ /m ²)
1	3,922	5,294.70	15,884.10	3.613
2	4,058	5,478.30	16,434.90	3.739

achieving the 17 Sustainable Development Goals of Agenda 2030, especially the ones related to redevelopment and recovery of abandoned areas by reducing the land take. In particular, it can be used by the PA to identify the most appropriate solution among different and contrasting objectives, by guaranteeing the financial conveniences of the subjects involved.

The proposed model is flexible, as it can be applied to similar national and international PPP interventions, can be easily implemented and allows the results of different scenarios to be compared according to the objectives to be pursued and the subject involved. Furthermore, it permits to facilitate the negotiation processes that take place among the subjects involved, effectively determining the urban parameters that affect the budget of the initiatives, avoiding their unsustainability.

Future developments of this research may concern the application of the proposed model to other case studies in order to generalize the proposed urban compensation-based model to further contexts and type of enhancement interventions, by including other economic and environmental aspects related to the process. In addition, the comparison with the results obtained from the analysis of discounted cash flows to verify the reliability and empirical consistency of the outputs obtained by including or excluding the time variable, may provide a useful contribution [31,32].

CRediT authorship contribution statement

Debora Anelli: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Francesco Tajani:** Validation, Visualization, Writing – review & editing.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.culher.2022.08.006](https://doi.org/10.1016/j.culher.2022.08.006).

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