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Original article

A model to support the public administration decisions for the investments selection on historic buildings☆

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ABSTRACT

The historical buildings can become an instrument for the growth of a territory in connection with the historic and artistic value, the ability to characterize environments and urban, rural and natural landscapes and on the basis of historical and documentary interest. This is confirmed in the numerous legislative measures that deal with urban planning at the international level. Most of the time, however, the interventions on the historical–architectural building heritage do not respond to logic capable of simultaneously ensuring the conservation and valorization. This problem is accentuated when the decision-making process is not supported by operating logical models capable of bringing into account the many effects of an investment, which are not only financial, but also social, cultural and environmental nature. The operational research, in particular discrete linear programming crossed with multicriteria analysis, can support the definition of useful models to the selection of investments on historical buildings. Intended for public authorities called to choose the projects to be financed, the model defined and tested in the present work can be easily adapted also to the case of resources allocation by private investor. The application of the model to a concrete case, concerning the definition of the projects portfolio for the valorization of buildings of historical–architectural value in a Municipality of South Italy, confirms the potential of the instrument in analysis.

1. Introduction

Like the principal European countries, Italy is experiencing a difficult economic-financial phase, sharpened from the strong incidence of public debt and the consequent dimension of interests to be repaid. In this scenery, in which do not remain margins for further tax levies, the only way to combat the crisis is to support the rigour and efficiency of spending through the development of strategies for the effective use of available resources.

Among the policies to which compete the greatest potential, stand out those that point to the development of the Public entities assets, in particular those on disuse or underutilized historical buildings. They are "buildings that are significant in the history of architecture, that incorporate significant architectural features, or that played significant historic roles in local cultural or social development; may or may not be officially designated" [1–3]. The redevelopment of these goods can act as a flywheel for the revival of entire urban areas, specially in the contexts characterized by an intense deterioration in which the cultural good represents often the only regard element of leverage [4]. The logic is to "produce" the good of cultural value in the respect of its properties, in order to generate benefits for all community [5–7]. In fact, historic buildings often located in the city centre of interesting areas from the environmental point of view constitute a catalyst for urban regeneration, due to their symbolic value for the entire community [8]. The European Framework Program for Research and Innovation (Horizon 2020) points out the positive effects that may result from the valorization of the public buildings of cultural heritage, as a synthesis of the traditional passive protection of these assets—that is proved unfit as well as financially unsustainable for the Public Administration—and their productive use, through modalities compatible with their nature and vocation [9–11].

In this context, a leading role is provided by the decision support tools for the selection of initiatives to be implemented [12–14], especially in the case of complex interventions, characterized by

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budgetary constraints, numerous variables in play, and the presence of stakeholders expressing conflicting interests and purposes [15–18].

In these circumstances it is necessary to employ a viable systems approach (VSA), that is an approach updated by considering implications of the highly dynamic environment that characterizes business contexts and in which complexity plays a central role [19]. This is an approach increasingly used in the field of investments on cultural goods, able to return an integrated reading of the property value as a function of the belonging context [20,21]. The VSA approach implements multidimensional models to rationalize the choices operated by multiple criteria that take into account simultaneously of financial, social, cultural and environmental aspects [22,23]. It is therefore to find the compromise solution which simultaneously maximizes the decisor objectives respecting the system constraints.

2. Research aims

With reference to the framework outlined in the present work it is defined and experienced a support model to public administration decisions involved in the definition of investment program on historical buildings in the case of budgetary constraints.

Starting from the set of projects presented to the financing, the model should allow:

- to isolate the initiatives "portfolio", capable of achieving better the programme objectives in the respect of the available resources and other constraints;
- to produce a reporting framework on which decision-makers can carry out rational and conscious assessments;
- to improve the coherence and transparency of the choices, with the translation of the constraints and programme objectives in mathematic relations of immediate understanding;
- to modify easily relationships that constitute the model constraints, so as to adapt them to technical, political and economic context each time considered.

Developed by crossing the linear programming algorithms with the multi criteria decision analysis (MCDA), the model is built using the *A Mathematical Programming Language* (AMPL) software. It is about a simple and intuitive tool used for structuring the mathematical programming problems. Then the resolution happens with the use of specific solver (CPLEX, FortMP, KNITRO, etc.).

This paper is structured as follows. In Section 3, notes on the applicability of linear programming and multicriteria evaluation to the valorization issues of cultural value goods are reported. In Section 4 there is outlined the model, of which the limits and potentialities are illustrated. In Section 5 the model is specified and applied to a real case, relative to the choice of a set projects for the historical–architectural buildings valorization to be carried out in a Municipality of South Italy, and the results are illustrated. In Section 6 the work conclusions are discussed.

3. Multi-criteria decision analysis and linear programming for the investment projects selection on historical buildings

The limits of the "pure" conservation of the historical–architectural building heritage-oriented policies become more evident when the evaluation of the interventions is conducted both by reason of the extra-monetary effects generated, and on the basis of the canonical performance indicators [24,25]. In fact, the MCDA provide an ample vision and systematic of the project effects, on the basis of quantitative and qualitative characteristic of the building to recover [26,27]. These are extrinsic and intrinsic factors that require the identification of criteria for evaluating the value of use and the proper value of the historical building. While the first one, said also instrumental value, refers to the cash flows that the building is able to produce on the time, the second, named intrinsic value or value independent from the use, expresses the whole of the relations that tie the good to the belonging context. The intrinsic properties relate to: (a) the environmental quality, (b) the historical quality, (c) the architectural quality, (d) the quality of any historical-artistic intakes inside, and (e) the age. Instead the environment-building relations relate: (f) the current usability, (g) the potential usability, and (h) the accessibility [28].

In reason of the historical building nature and its uniqueness and not reproducibility, the resort to the MCDA techniques lets take into account then in the evaluation of multiple aspects useful to protect the integrity of the good and to satisfy the needs with the community [29,30].

Operationally, the MCDA faces the projects selection problems through two steps:

1. *preliminary analysis*, aimed at identifying the alternatives and their socio-cultural and environmental components affected by the intervention.
2. *economic evaluation of projects*, according to the impact generated on the various components.

It is evident that the choice process needs rational, transparent models easy to use, aimed at identifying the best solution in respect of legal, technical, administrative, social and/or economical constraints that connote the system.

A valid support to this purpose is given by operational research algorithms, that allow to solve problems about the optimal use of scarce resources in complex contexts characterized by numerous constraints and many variables [31]. In fact, many cases of selection can be effectively solved with optimization algorithms writing mathematical programming functions of the type:

$$\begin{cases} C(x_1, \ldots, x_n) \\ \varphi_m(x_1, \ldots, x_n) \leq b_m \\ x \in X \end{cases}$$

where x_i is the ith variable of the problem; $C(x)$ is the objective function; (φ_m) represents the set of constraints, with the vector of known terms b_m which provides the limits to be respected in the definition of the optimal value [32,33].

The analysis scheme must formalize the decision-making problem using a mathematical language capable of simulating the behaviour of the economic system investigated [34].

Frequently, both the objective function and the set of the constraints are expressed through linear relations, which return therefore a linear programming model. Although the assumption of linearity may seem restrictive in relation to the complexity of the real phenomenon, it generally does not cause excessive approximations and finds ample feedback in practice, as it is evident in the context of the selection between interventions for the recovery and valorization of the historical–architectural heritage [35,36].

The applications of linear programming are in many disparate sectors. In particular, they are:

- in corporate finance and project management [37–44];
- in land-use planning [45,46], as well as implementing geographic information systems [47–49] and with the elaboration of decision maps able to consider territorial components of different nature [50,51];
- in urban planning and economic projects evaluation [52–56].

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