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Decision Support Systems for evaluating urban regeneration

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Abstract

The present article focuses on Decision Support Systems in the context of urban planning and regeneration processes. In particular, the article presents different typologies of decision problems that can arise in urban regeneration and discusses the possible answers given by evaluation tools. The dissertation is based on the presentation of real world applications, including the selection among different alternative urban scenarios, the assessment of the financial feasibility of an urban infrastructure and the definition of a multidimensional evaluation tool of health and hygiene performances of urban planning.
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Keywords: urban planning; multicriteria analysis; cash-flow analysis; indicatos and indices

1. Introduction

This paper discusses the role played by evaluation to support decisions in urban planning and regeneration processes. The interaction among evaluation and planning processes has been examined both from a theoretical and a practical point of view (Khakee, 1998; Lichfield, 2001), with reference to the purpose and the scope of planning evaluation, and to its methodological innovations and improvements. The increasing attention placed on the process for developing urban plans and on the effects of the planning choices underlines the complexity of defining shared objectives, collecting data as basis for identifying a set of possible solutions, as well as forecasting their

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consequences according to different development scenarios. Under this perspective, planning processes should be seen as decision processes. Starting from the analysis of strengths and weaknesses the decision context and passing through a crucial phase of problem structuring, planners are called to investigate needs and preferences, to set out objectives and exploring the outcomes of the strategies in order to identify the most satisfying choice, to be implemented and monitored (Las Casas, Tilio&Tsoukias, 2012). Along with this cycle of activities, evaluation provides a rational support for facing the complexity and it allows to verify the effectiveness and soundness of choices by increasing their transparency and enhancing collective learning processes (Bentivegna, 1995). Furthermore, the increasing attention to the concept of sustainable urban development, meant as ongoing process rather than a fixed condition, has stressed the relevance of evaluation for gauging progresses in improving environmental quality, social wellbeing and economic growth according to a long term horizon time. At the same time, given the instance of measuring cities' progresses towards sustainability, a value-focused thinking approach has progressively emerged as conceptual framework for integrating values into decision-making activities by making explicit the direction of preferences (Keeyney, 2002).

The paper is divided into 4 sections. After the introduction, the second section is aimed at describing various evaluation techniques used with different purposes related to the scale of the project and to the phase of the operation in which the takes place. The third introduces three case studies that exemplify the evaluation techniques above described by putting in evidence the results obtained with reference to the initial settings. The last section summarizes the main conclusions of the work done.

2. Evaluation methods

As already mentioned, urban regeneration processes are multidimensional concepts which includes socio-economic, ecological, technical and ethical perspectives. Decision problems in the domain of urban regeneration processes represent "weak" or unstructured problems since they are characterized by multiple actors, many and often conflicting values and views, a wealth of possible outcomes and high uncertainty. Under these circumstances, the evaluation of alternative projects is therefore a complex decision problem where different aspects need to be considered simultaneously, taking into account both technical elements, which are based on empirical observations, and non technical elements, which are based on social visions, preferences and feelings (Munda, 2004).

In this context, lots of evaluation techniques and tools are available, depending on the phase on which the evaluation takes place (i.e., before, during or after the construction of the project) (Table 1).In the ex ante phase, the evaluation tools are necessary to support the formulation of the project, providing information both on the strategies (that are represented by the objectives that the project is likely to pursue) and the visions (that are the actions that the project will implement in order to reach the objectives). The in itinere phase is mostly related to control if the project meets the initial objectives, putting in evidence the unexpected effects, while in the ex post phase the evaluation process can help to make a final balance of the experience and to inform the Decision Makers and the stakeholders about the final results that the project attained.

Table 1. Taxonomy of the evaluation approaches (source: elaboration from Bezzi 1998).

	Ex-ante	**In-itinere**	**Ex-post**
WHY	To formulate the project	To control if the project meets the initial objectives, putting in evidence the unexpected effects	To learn from past experiences and to inform Public Authorities and population
WHEN	Before the preparation of the project	During the construction phase	After a reasonable period of time
WHAT	Strategy (i.e., identification of clear goals that advance the overall project) and tactic (i.e., organization of specific resources to achieve sub-goals that support the defined mission)	Tactic with reference to the strategy	Mostly the strategy, then the tactic
HOW	Scenario building Experts judgments Cost-Benefit Analysis Discounted Cash flow Analysis Multicriteria Analysis	Performance indicators Documents analysis Monitoring data	Surveys Analysis of the effects Econometric models

3. Applications

3.1. Application of Multicriteria Analysis for comparing alternative scenarios of urban transformation

Decision problem

The case study that has been considered for the application refers to the transformation of an urban area in the city of Torino (Italy) (Bottero, Ferretti &Mondini, 2015). The area is located in a strategic zone of the city, close to the train station, the University campus and the most important executive headquarters buildings. In spite of its strategic position and intrinsic value, the area represents nowadays an urban void and different transformation projects are under consideration. The three main alternative scenarios for the area concerns 1) the construction of a conference centre, 2) the construction of a multifunctional building integrated with a shopping mall and 3) the realization of an urban park, relocating the construction of the facilities in another part of the city.

Evaluation method

The Multi-Attribute Value Theory (MAVT) (Keeney &Raiffa, 1976) is a specific Multicriteria Analysis technique(Belton & Stewart, 2002) that can be used to address problems involving a finite and discrete set of alternative options that have to be evaluated on the basis of conflicting objectives. By being able to handle quantitative as well as qualitative data, MAVT plays a very crucial role in the field of urban regeneration decision problems where many aspects are often intangible. Moreover, decision-making in this context is often complicated by various and conflicting stakeholder views that call for a participative decision process able to include different perspectives and facilitate the discussion.A set of measurable attributes has been identified for the evaluation of the alternatives and it has been organized according to the value tree approach (Fig.1.a). Following the MAVT methodology, each attribute is described by a value function which allows to scale the attributes between 0 and 1 in order to compare non-commensurable items. Once the alternatives have been evaluated, it is necessary to define the importance of the different attributes of the decision problem. In this case the Swing method has been appliedwhich explicitly incorporates the attribute ranges in the elicitation question. In particular, the method asks to value each improvement from the lowest to the highest level of each attribute (Montibeller& Franco, 2007) by using a reference state in which all attributes are at their worst level and asking the interviewee to assign points (e.g. in the range 0-100) to states in which one attribute at a time moves to the best state. The weights are then proportional to these values. The Swing method has been developed making use of an panel of experts with expertise in the field of environmental engineering, urban planning and economic evaluation. The single attribute value functions have then been aggregated using the obtained set of weights and additive assumptions to calculate the total value of the specific alternatives.

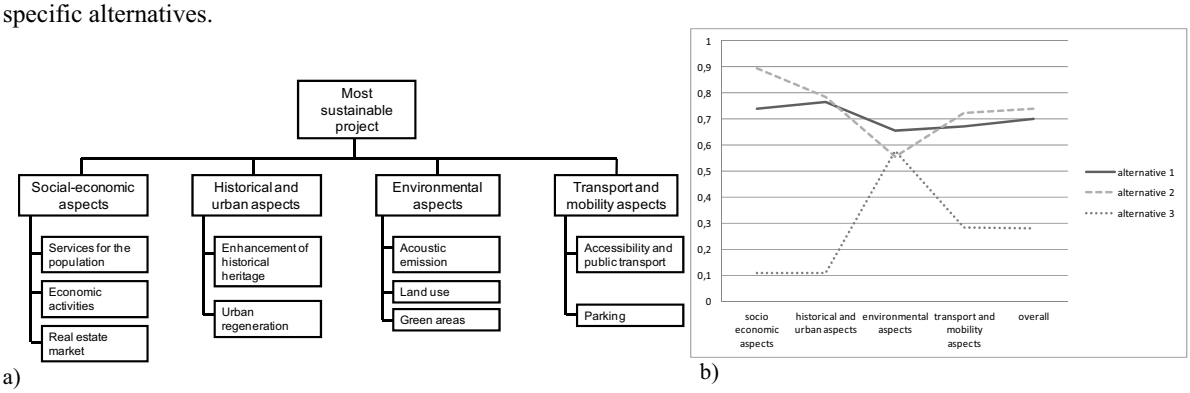

Fig. 1. The value tree for the decision problem (a) and results of the MAVT application (b) (source: Bottero, Ferretti &Mondini, 2015)

Results and role played by the evaluation

From the priority list obtained by the MAVT model, scenario 2 and scenario 1 have very similar performances and that their overall scores thus present negligible differences while scenario 3 represents the least preferred option.

This result is also confirmed by sensitivity analysis, showing that the scenario 2 has the best performances in the considered sensitivity sets of weights while the scenario 3 ranks worst in the most part of the sets (Fig. 1.b).

3.2. Development of cash flow analysis for feasibility assessment of an urban infrastructure

Decision problem

The case study is related to the evaluation of the project for the development of a new urban axis in the city of Skopje in the Republic of Macedonia (Bottero, 2015). In particular, the project refers to the design of the Southern Boulevard, which is an urban axis crossing the city from East to West. The project, developed by the Urban Center of Torino, consists in a series of works which aims at reorganizing the urban infrastructural system and, at the same time, at redeveloping large portions of the city whihc now are suffering from a poor mobility network, a lack of public spaces and a low urban quality.

Evaluation method

The project was evaluated in order to investigate the financial-economic feasibility of the operation. This is normally addressed through the Discounted Cash Flow Analysis (DCFA). Particularly, this technique is used to derive economic and financial performance criteria for investment projects (Manganelli, 2015) in the form of synthetic and easy to interpret indicators that allows the Decision Maker to understand if the project should be accepted or rejected. The most used project performance criteria are the Net Present Value (NPV) and the Internal Rate of Return (IRR).

The evaluation of the profitability of the operation has been based on the estimation of the benefits in terms of foreseen incomes derived from real estate sales and of the factors regarding the production costs. Once having estimated cost and benetif items, it was necessary to create a cash flow by distributing them over a temporal period. The final steps consisted in the calculation of the performance indicators.

Results and role of the evaluation

According to the calculation the IRR was equal to 7,8% thus the operation was feasible. Also in this case, the results were further verified by means of a senstivity analysis that consisted in modifying the estimation of the costs and benefits and in examining the effects of these variations on the final IRR indicator. As it is possible to see from Figure 2the most sensitive variable is represented by the construction costs of the residential buildings meaning that this variable is crucial for the overall process and should be carefully monitored in the subsequent steps of the project.

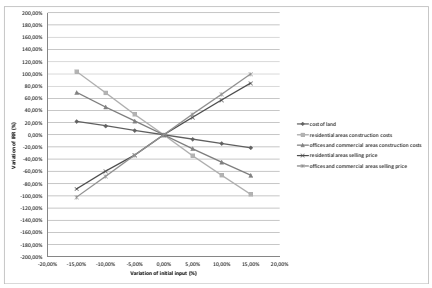

Fig. 2. Sensitivity analysis for the IRR indicator

3.3. Definition of a set of indicators for measuring health performance of urban planning

Decision problem

This case study shows a multidimensional evaluation framework, to be used iteratively for addressing urban plans and programs towards the enhancement of health performances, for monitoring progresses, as well for developing an

ex-post evaluation (Capolongo, Buffoli&Oppio, 2011; Capolongo, Battistella, Buffoli&Oppio, 2015). Health, quality of life and sustainable development are strongly interconnected. Actually many of the problems of the cities like pollution, inequity, lack of services and accessibility depend on poor urban development. The prominence of global competition has forced cities to improve the design and management of urban built environment, that are the major determinants of health. According to the WHO' s wide definition of wellbeing, the conditions in which people live and work, their access to facilities and services, their lifestyles and their capability to build strong and long-term social networks are crucial drivers of public health.Several are the European initiatives aimed at measuring and monitoring the level of sustainability and quality of life of local communities by different set of on environmental, social and economic criteria. Among these, the 'Who' Healthy city project has launched the challenge of exploring the relationship among urban quality and health gains.

Evaluation method

Within this context, a multidimensional evaluation tool has been defined by an interdisciplinary research group (Politecnico of Milano and the Prevention Department of Asl Milano) with the aim of: a) providing an overall score of health performances of urban programs and plans; b) supporting the assessment activity of technicians of the Asl Milano, who are committed to express an opinion about the impacts of urban plans and programs on health; c) increasing planners and public awareness about the link between quality of built environment and public health. The decision problem of improving urban planning under the perspective of Public Health has been hierarchically decomposed into six different thematic areas, namely Environmental quality and wellbeing, Waste, Energy and renewable resources, Mobility and accessibility, Land use and functional mix, Quality of urban landscape, that were further subdivided in criteria. Each criterion has been specified by an assessment card aimed at explaining the goal it drives to achieve, its impact on health, a performance evaluation score, a selection of best practices. The performance values are expressed by a score, that goes from 0 (inadequate performance) to 3 (good practice), and by a reference judgement, aimed at pointing out those requirements that are crucial for reaching the highest score.

The overall score of each plan/project is given by the score achieved at the level of the 6 thematic issues, that is once more given by the score achieved at the lower level of each criterion. In order to highlight weaknesses and strengths of the urban plans and programs under evaluation and especially to point out corrective actions for effectively addressing health's concerns, the final result are displayed by a spider diagram, that shows the score achieved by each thematic issue (Fig. 3), and three kind of histograms, the first that provide the overall score o22f the urban plan/project, the second that focuses on the scores achieved by the thematic areas and the last that explains the score of each criterion.

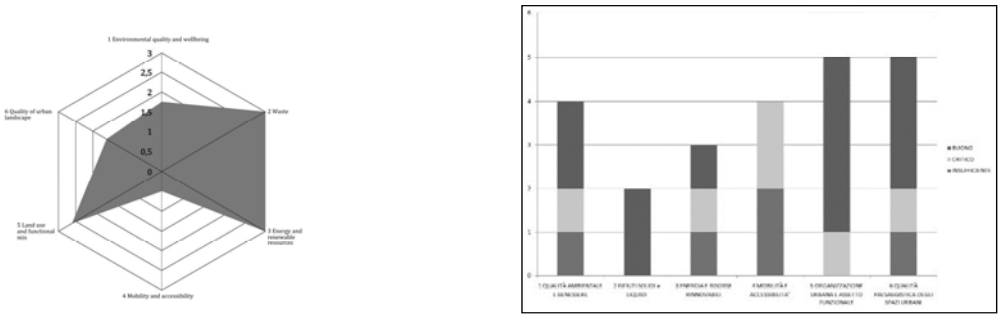

Fig. 3 Output of the evaluation process

Results and role played by evaluation

By the iterative use of the proposed evaluation tool, local authorities are able to support urban planners by providing them with a clear and effective benchmark as a starting point for boosting built environment improvement under the health and well being perspective. According to a long-term perspective, it is expected that a wide use of such an assessment tool will provide a better knowledge about the multidimensional nature of urban health, its all

constituents and their combined effect over time, and that it will give a relevant contribution for better integrating public health concerns into planning processes (Lawrence & Fudge, 2009).

4. Discussion and conclusions

Starting from real world applications, the article reflects on the role played by different evaluation tools in supporting decision making processes in the context of urban regeneration processes. The results of the application allow to point out the main differences existing among the considered methods (Table X).

Table 2. Main issues addressed by the considered evaluation tools

Relevant issues	MAVT	DCFA	Performance indicators
Integrated evaluation (frameworks able to consider simultaneously the different elements of the decision problem)	✓		✓
Decision Makers preferences and justification of the choice (tools useful for representing the DMs' preferences and for justifying the final decision)	✓		
Participation in the decision and construction of a learning process (techniques able to support the participation of the stakeholders in the decision)	✓		✓
Communication of the results (approaches useful for producing results easy to be interpreted and communicated to the actors)		✓	✓

Although the differences of the evaluation demands, the evaluation tools above described i) consider the multiplicity of objectives and values when dealing with urban regeneration processes and include the opinions and the needs of the different stakeholders involved; ii) are sensitive to the every changing decisional context; iii) are able to figure out the consequences of the alternatives under investigation. According to the proposed case studies, urban regeneration is intended as not only buildings restoration operations, but also programmes aiming at eliminating social decline, increasing the quality of life of the inhabitants, supporting the valorization of cultural resources, protecting the environmental system, bringing economic development and so on. Taking into consideration this complex decision environment, the evaluation methods discussed in the present work proved to be effective not only in exploring possible solutions but also in supporting the management of decision processes with reference to a long-term approach.

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