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Decision Support

A multi-methodological combination of the strategic choice approach and the analytic network process: From facts to values and vice versa

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ABSTRACT

The paper proposes a new multi-methodological framework combining a Problem Structuring Method and a Multi-Criteria Decision Analysis to address the problem of composing facts and values in the decision-making process of policy making. We position our work theoretically in relation to Latour's concept of the "collective" as a potential description of the decision-making process, with its conflicts and negotiations, openings and closures. With Latour, we can say that there are no "separate chambers" in which facts (i.e., the use of public resources, different time horizons) and values (i.e., the values of different stakeholders, the legitimacy of public decisions) are discussed; rather, all these aspects are considered together in a cycle that encompasses them, progressively expanding and contracting to arrive at a tangible result: a decision. In the paper we illustrate the transposition of the concept of this cycle in our multi-methodology, the proposal of the combination of the Strategic Choice Approach (SCA) and the Analytic Network Process (ANP)—which is absent in the literature—and we then empirically test this theoretical contribution with a case study, the repurposing of a former hospital in Italy.

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1. Introduction

The importance of problem structuring—and Problem Structuring Methods (PSMs) specifically—for Multi-Criteria Decision Analysis (MCDA) has been acknowledged in the literature and practices of the last 20 years (Belton & Stewart, 2010; de Sousa Pereira & Morais, 2020; Franco & Montibeller, 2010; Gomes Júnior & Schramm, 2021; Marttunen, Haag, Belton, Mustajoki & Lienert, 2019, 2017; Witt, Dumeier & Geldermann, 2020), advancing beyond the idea that MCDA starts from a well-structured problem. This shift in perception has led to the recognition that problem structuring is central to providing a richer view of the problematic situation for the subsequent phases of MCDA (Marttunen et al., 2017). However, while the literature has scrutinized the crucial advantages that PSMs (Rosenhead, 1989, 1996; Rosenhead & Mingers, 2001) can bring to MCDA (Belton & Stewart, 2002; Figueira et al., 2016), little attention has been directed to an opposite point of view, viz., on reflecting on any aspects or weaknesses shown by PSMs in the process that can be balanced through integration with MCDA.

In this paper, we aim to address this lack of attention to the ways of tackling complex socio-technical phenomena (Callon, 1986; Hassard, Law & Lee, 1999; Latour, 1987; Latour & Woolgar, 1979; Pinch & Bijker, 1987) starting from a perspective that is first and foremost based on PSMs. We propose a combination of the Strategic Choice Approach (SCA) (Friend & Hickling, 1987, 2005) and the Analytic Network Process (ANP) (Saaty, 2005; Saaty & Vargas, 2006) which, as far as we know, is absent in the literature. SCA belongs to the family of interactive and participative PSMs (Mingers & Rosenhead, 2004), whose aim is to structure, rather than solve, the problematic situations to be faced (Rosenhead, 1989, 1996). ANP is a multi-criteria methodology used to capture different aspects of a problem by comparing intensities of preference and deriving meaningful numbers. Based on the authors' experience, having already delved into the theory and application of the methods individually, ours research has, instead, been carried out to explore the potential for combining the two. Building on current interest in the process and dynamics of interventions in Operational Research (OR) (Keys, 1997; White, 2009, 2016), we position our work theoretically in relation to social constructivism, considering interventions in socio-technical terms. In doing so, we draw on Latour's (2004) concept of the "collective" as a potential description of the decision-making process, with its conflicts and negotiations, openings and closures. The "collective" as a

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procedural movement is widely used as a description of complex socio-technical phenomena to which Actor-Network Theory (ANT) can be applied (Callon, 1986; Latour, 2005; Yaneva, 2009), as considered also by OR scholars (see, for example, Burger, White & Yearworth, 2019; White, 2009; Yearworth & White, 2018).

Methodologically, our approach is built on important work in OR that has categorized the possible combinations of PSMs and MCDA as sequential, embedded, or integrated implementation (Marttunen et al., 2017). The multi-methodology here presented combines the two methods in an integrated implementation. SCA is used to tackle the decision problem in terms of structuring the problem and defining scenarios. Next, ANP is applied to evaluate options and compare alternatives. In this way, the multi-methodological approach benefits from specific features and paradigms of the combined methods.

Finally, we take as our example a case study of the adaptive reuse of a former hospital in central Italy, showing how our multi-methodology can be applied to support the decision-making process of policy making, a central domain of the debate on PSMs.

2. A socio-technical perspective in PSMs

PSMs interventions imply a process of integration among technical and social aspects (Keys, 1997, 1998; White, 2009) to produce knowledge and social relations. ANT (Callon, 1986; Hassard et al., 1999; Latour, 1987; Latour & Woolgar, 1979; Pinch & Bijker, 1987) allows these aspects to be understood together in terms of their integration. Indeed, ANT studies complex situations of the real world in which both people and technologies are considered and "traced" (Boerboom & Ferretti, 2014; White et al., 2016) in their relationships, and has been brought progressively into use in investigating PSMs interventions (White et al., 2016; Yearworth & White, 2018). According to White (2006, 2009), ANT allows examination of how such interventions are socially constructed through a bundle of socio-technical interactions and co-produced through hybrid actor-networks that relate and evolve in these relations over time (Latour, 1987). In this sense, the process of interventions can be usefully studied using concepts from ANT (Keys, 1997, 1998; White, 2009). Moreover, since even the outcomes of interventions depend on the above-mentioned complex interactions among entities, we propose here to start from ANT as a theoretical basis to support both the process and the outcomes, tracing the proposal of multi-methodology back to specific concepts proposed by Latour (2004).

Dealing with PSMs for addressing social issues (Coelho, Antunes & Martins, 2010; Howick, Ackermann, Walls, Quigley & Houghton, 2017; Paucar-Caceres et al., 2020; Todella, Lami & Armando, 2018; Fregonese, Lami & Todella, 2020), the process is inherently complex and involves several stakeholders, many potentially conflicting values, and a broad range of technical, social, political, economic, and environmental issues (Coelho et al., 2010; Gomes Júnior & Schramm, 2021; Rosenhead & Mingers, 2001). According to Latour (1987), reality is progressively shaped, diverted, and consolidated, and, rather than considering "social" as a specific and identified realm and the context "in which" everything is framed, society comes from operations of re-association and reassembling (Latour, 2005). In this respect, we explore a framework to effectively support decision makers along the process, as a methodology for comprehensively structuring, designing, testing, and implementing the decision itself in the process.

2.1. From facts to values and vice versa

To develop a theoretical model in combining PSMs and MCDA, we propose to introduce an extended conception of ANT, already present in the OR debate, suggesting Latour's concept of the "collective." This abstract and potentially all-encompassing model was conceived by Latour (2004), starting from a reflection on political ecology, as the overcoming of a gap between science (i.e., natural reality) and politics (i.e., social reality). The aim was to eliminate the distinction between nature and society, facts and values, objects and subjects, humans and "non-humans," to "read scientific truth" as based on an *a priori* defined division of roles. In Latour's perspective, this separation results in public life reducing political thought to the legitimation of already accomplished and interpreted facts, thus basically neutralizing democracy through an acceptance of truth that should depend on political debate (Latour, 2004, pp. 14–15).

Latour's concern with constructing an agon and field of action without *a priori* guarantees is particularly relevant today: he postulates that it is not only the subjects/actors with their convictions who challenge each other, but also the objects/actants. Indeed, we are increasingly dealing with "matters of concern" and uncertain objects, capable of disruptive, often unexpected, and uncontrollable consequences (i.e., the so-called "mad cow" disease, the hole in the ozone layer, the Covid-19 pandemic), with both scientific and social problems. In the "collective," the actants exist by virtue of the effects they produce, and their actions can be measured by the traces they leave behind, since "we talk about a crisis every time they emerge" (Latour, 2004, p. 24). Rather than two distinct arenas of nature/society, the proposal is a single "collective" in which a hierarchy among the involved entities can be debated in order "to arrive at an acceptable solution" (Latour, 2004, p. 29). In this sense, this "collective" notion recalls a procedure of "collecting" associations to reach a not already established unit, reality, and common world. In this model, the progressive integrations of emerging irruptions are the only possibility for allowing the system not to get stuck, as the "the hard labor necessary for the progressive and public composition of future unity" (Latour, 2004, p. 59).

According to this notion of the "collective," and its capacity to describe complex socio-technical phenomena, we believe it might contribute to the OR debate, where the decision-making is considered as both a social and a technical problem. We are attempting to test it empirically, describing first Latour's "collective" and then illustrating the connections we see with PSMs, considering the aim of taking into account problematic and emerging issues and of modifying the system—the decision-making system—so that it proceeds by encompassing the modification.

In the "collective" circular process (Fig. 1), a new problem emerges (phase i), followed by needs to be recognized and articulated, evaluated and measured (phase ii); then an order of priority has to be built up (phase iii), and then instituted (phase iv). Technical objects and social actors are linked together in the "collective," since "facts," on the one hand, relate to external reality in its emergence, as a problematic situation (Latour, 2004, p. 103), while "values," on the other hand, relate to the voices to be considered, with respect to the same reality (Latour, 2004, p. 105). In this sense, this circular process consists in a cycle of transactions and negotiations—from facts to values and vice versa—for the process to proceed, in an alternation of "complication" and "unification" (Latour, 2004):

(i) the *complicating facts* relate external reality in its emergence, as the problems and concerns that irrupt and arise in a process, creating an emergency and calling for actions and decisions (phase i, or perplexity). This first phase is the most debatable;
(ii) the *complicating values* can be invoked in exploring and unpacking the problem, as the actions of considering and articulating multiple aspects and demands (phase ii, or consultation). This second phase implies including other voices not yet considered;

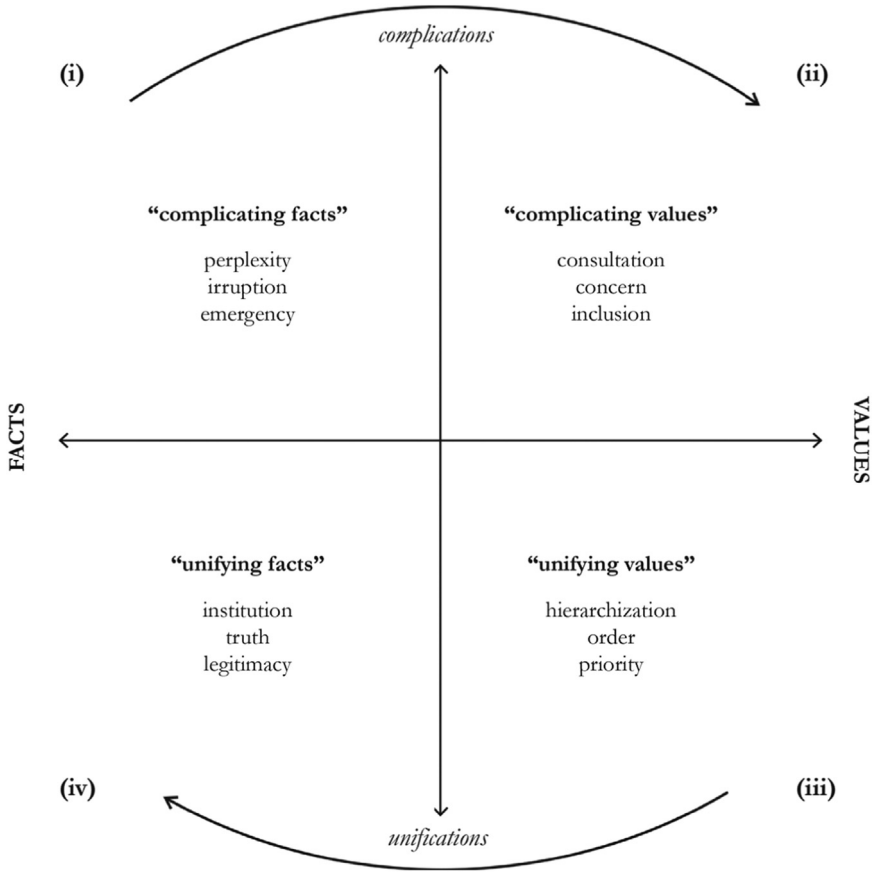


Fig. 1. The "collective" cycle (Latour, 2004, p. 115), adapted from Armando and Durbiano (2017, p. 305), our translation.

(iii) the *unifying values* establish the relative importance of each entity, building hierarchies and priorities among the multiplicity of aspects that have emerged (phase iii, or hierarchy). This third phase consists in arranging entities in rank order giving them their legitimate place;
(iv) the *unifying facts* relate external reality in its institution, establishing that the problem's resolution is well-grounded and legitimate at the heart of collective life (phase iv, or institution). This last phase is the least debatable.

In the following pages, we further develop our theoretical perspective by first discussing the aspects of policy making that might benefit from applying Latour's concept. We subsequently build our approach to tackling complex socio-technical phenomena by focusing on the transposition of the concept of collective in multi-methodologies composed of PSMs and MCDA, thus enhancing the case of SCA and ANP. We then empirically test the theoretical contribution with a case study, to discuss the possible contribution to OR of the new multi-methodology.

3. A multi-methodological approach combining PSMs and MCDA

The theoretical perspective of Latour's cycle and the related multi-methodology proposed in this study aim to support the decision-making process of policy making, a central domain of the debate on PSMs. Policy making has been a traditional domain of research and practice, where decision analysts have introduced formal methods aimed at helping policy makers improve their decisions. As underlined by Tsoukiàs et al. (2013), policy making is a type of decision process with specific characteristics, thus demanding dedicated analytical methodologies. Moreover, in recent years, the field of decision analysis has been heavily influenced by the "analytics" perspective, which integrates advanced data mining and learning methods, often associated with the use of dedicated software. Policy makers are confronted by five major complexities concerning public decision-making: the use of public resources; multiple stakeholders; a long time horizon; legitimation and accountability; deliberation (Tsoukìas, Montibeller, Lucertini & Belton, 2013).

We suggest that Latour's cycle offers a powerful scheme that is useful for shedding light on and tackling these peculiarities of public decision-making. With Latour, we can say that there are no "separate chambers" in which facts (i.e., the use of public resources, different time horizons) and values (i.e., the values of different stakeholders, the legitimacy of the public decisions) are discussed; rather, all these aspects are considered together in a cycle that encompasses them, progressively expanding and contracting to arrive at a tangible result: a decision.

Latour's cycle is a kind of meta-script—i.e., a script or model—applicable to any controversy that is proposed to describe how collectivities proceed and arrive at decisions, holding together moral and ethical issues with more technical, scientific, and objective ones. If the cycle of the "collective" is applied, for example, to the epidemiological history of the last three years, it can be seen how the virus was the agent that connected all dimensions of our human existence, which must be translated into chains of actions (passing from economics to politics, from science to entertainment, etc.) so that this virus can be brought back to a condition of coexistence acceptable to humanity. In this context, the moment of irruption, the first quadrant, was when Covid-19 arrived. Nobody knew anything about it. People were dying and no one knew why. The moment the virus was isolated, the second quadrant was "entered": the actor was identified, and a description

could be made. The third quadrant concerned the different options for action to be compared and on which to make a choice ("Do we apply restrictive measures, or do we leave people free to move? Do we invest more in a vaccine, or do we opt for a rigid lockdown and increase forms of control?"). The entry into the fourth quadrant, finally, was represented by the World Health Organization's establishment of vaccines deemed valid, which was the moment when the cure for the virus was established. As is well known, there are people everywhere who do not recognize this institution and who fight back, breaking back into the cycle and initiating other cycles.

In public decision-making we face precisely such complicated issues (the virus, climate change, the development of sustainable cities, self-driving cars, etc.), where it is impossible to separate the moral or ethical aspects from the technical ones. Here, the contribution of OR is to build proceduralities that allow the measuring and comparing of decisions, which are communicable and justifiable.

We suggest that Latour's cycle might help to reflect on which methodologies and approaches best respond to irruptions, integrating them into the decision-making process. Looking at the distinction in Latour's cycle with respect to the x-axis, at the top, tools that diverge, explode, describe, and analyze are necessary, while, at the bottom, approaches that condense, implode, unify, and synthesize are needed. These two types of tools have been discerned in methodologies inherent in PSMs and MCDA. PSMs and MCDA have attracted growing theoretical and practical interest over the past 20 years, and the methods' combination for dealing with complex problems is an emerging topic (Gomes Júnior & Schramm, 2021).

On the one hand, PSMs (Rosenhead & Mingers, 2001) are a family of participatory and interactive methods whose purpose is to assist groups to tackle a complex problematic situation of common interest (Franco, 2006), structuring problems rather than solving them directly. They are used by groups of stakeholders in a workshop setting (Franco, 2013; Franco & Montibeller, 2010) to explore possible future scenarios and to investigate the space for multiple solutions. In this sense, PSMs assist participants in understanding the problem, addressing their interests, and aligning solutions to their goals (Cunha & Morais, 2017; de Sousa Pereira & Morais, 2020; Lami & Tavella, 2019). In a parallel with Latour's cycle, in our view PSMs generally provide tools that diverge and analyze (Fig. 2), since they deal with an uncertain status that needs to be considered (phase i, or *perplexity*), when new "facts" and entities appear and perplex those who debate a problem (Latour, 2004, pp. 103–104), implying a controversy and new issues to be considered in the discussion. Then, PSMs also allow for an extension of the number of interested parties in the discussion (phase ii, or *consultation*), when new "values" and voices ask to participate in the articulation of the problem (Latour, 2004, pp. 105–106), emphasizing the importance of those who must sit in the arena. To allow the "collective" to proceed to a decision, PSMs help answer a problematic situation through "the power to take into account: how many are we?" (Latour, 2004, p. 109).

MCDA (Figueira et al., 2016; Ishizaka & Nemery, 2013; Munda, 2019), on the other hand, is an umbrella term for quanti-qualitative approaches aimed at supporting the systematic evaluation of alternatives in terms of multiple and often conflicting objectives. MCDA aims at helping decision makers in the identification of a number of criteria on which to base the decision, minimizing the potential for post-decision regrets with respect to the fact that all relevant issues have been properly taken into account (Belton & Stewart, 2002). In a parallel with the "collective" cycle, in our view MCDA provides tools that condense and synthesize (Fig. 2), since

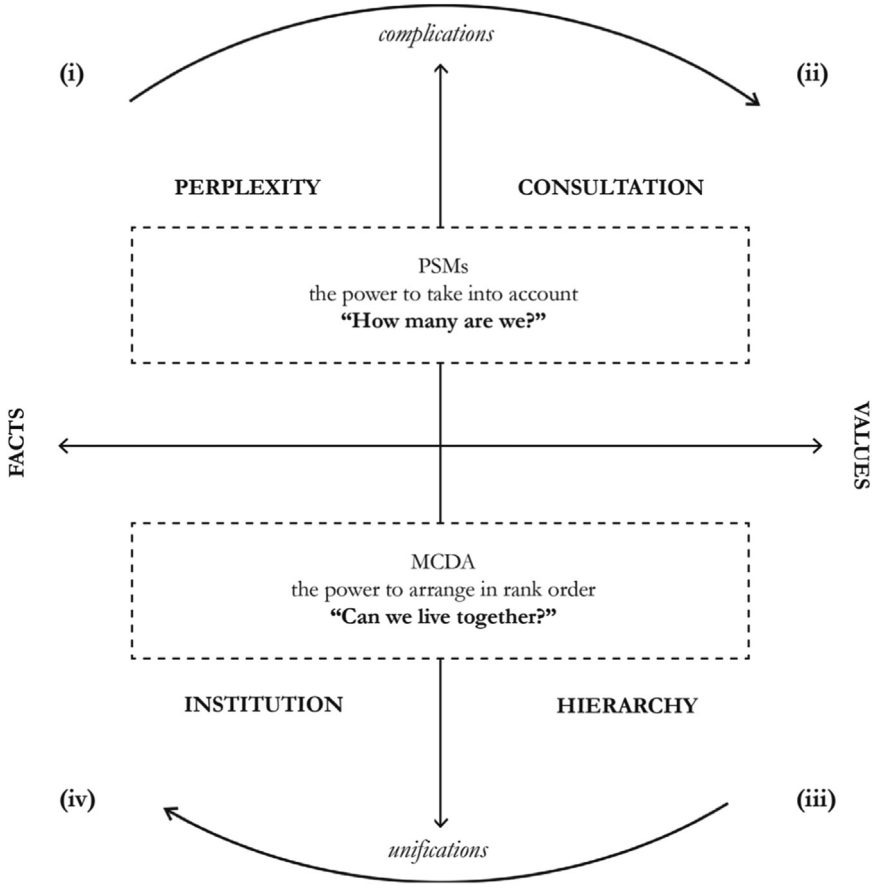


Fig. 2. An interpretation of PSMs-MCDA multi-methodologies, framed in Latour's cycle.

they deal with the arrangement of the new entities in terms of their compatibility and relative importance with the already established issues (phase iii, or *hierarchy*), when the emerged "values" should be confronted with the choices already made, with the decisions already taken, finding their rank and place (Latour, 2004, pp. 107–108). Then, MCDA also allows for a recognition and agreement about the new ordered and established entities (phase iv, or *institution*), when the emerged and discussed "facts" become legitimized, as evidence, and agreed (Latour, 2004, pp. 104–105). To allow the "collective" to proceed to a decision, MCDA helps answer the need of solving the problem through "the power to arrange in rank order: can we live together?" (Latour, 2004, p. 109).

In terms of the contributions that PSMs make to MCDA, problem structuring is widely recognized as a helpful improvement in many complex decision-making situations, as it makes it possible to understand and articulate a problem's different values and perspectives and thus identify alternative courses of action for dealing with it (Keeney, 1992). Since MCDA does not include stages for defining problems, exploring the uncertainties, and developing alternatives (Franco & Montibeller, 2010), combining it with PSMs can ensure a deeper analysis and an integrated support, from problem structuring to evaluation (Belton & Stewart, 2010). Indeed, PSMs can assist stakeholders or participants in the understanding of several issues—and their relations—in a problematic situation (Coelho et al., 2010), and to properly participate in the process and prior to defining appropriate actions (Cambrainha & Fontana, 2018).

The importance of problem structuring for MCDA has thus been acknowledged in the literature and in practices (Ferretti, Pluchinotta & Tsoukiàs, 2019; Franco & Montibeller, 2010), as it can consider all the consequences of key choices from a more comprehensive—i.e., environmental, technical, economic, political, and social—point of view. However, while there is an extensive literature on the advantages that PSMs can bring to MCDA, little attention has been given to the opposite point of view, i.e., the weakness that PSMs may have in the process, and which could be balanced through integration with MCDA. Indeed, many recent MCDA applications, besides simply guiding discussions to choose between alternatives (Belton & Stewart, 2002; Marttunen et al., 2017), focus on broadly supporting different types of problems, as stated by Marleau Donais et al. (2019): (i) choosing issues, in terms of selection among alternatives; (ii) sorting issues, in terms of classification of alternatives to categories; (iii) ranking issues, in terms of ordering of alternatives. In this sense, we think that MCDA for PSMs could allow for a better exploration of the alternatives themselves, facilitate communication, and support shared and transparent solution finding, using the involved stakeholders' preferences (Dimitriou, Ward & Dean, 2016; Marleau Donais, Abi-Zeid, Waygood & Lavoie, 2019; Marttunen et al., 2017; Ram, Montibeller & Morton, 2011) to deal with prioritization and evaluation (Lami & Moroni, 2020).

3.1. Framing the SCA-ANP multi-methodology

Once PSMs and MCDAs were identified as suitable approaches to support decision-making according to Latour's quadrant distinction, the next step was to define which methodologies were specifically best suited. These have been recognized in SCA and ANP for several reasons, visible in framing the proposed multi-methodology in Latour's cycle:

1. Problem structuring with SCA: the shaping mode in SCA relates the "perplexity" phase where the problem comes to the fore. This first mode of SCA aims to support the detection of all the issues related to the problem to be faced;
2. Option designing with SCA: the designing mode in SCA can be likened to the "consultation" phase, in which each aspect of a defined problem is articulated. This second mode of SCA aims to develop several alternatives and scenarios, which include the whole range of entities and aspects involved in the process;
3. Pairwise comparison through ANP: the network creation and the pairwise comparisons in ANP can be likened to the "hierarchy" phase, in which the alternatives have to be evaluated, building orders of priority, and measuring the combined consequences of several scenarios;
4. Defining a preferred solution through ANP: the aggregation of the results and ranking in ANP reflects the "institution" phase, in which—after alternative solutions are evaluated and measured—a choice is made about the overall problem, or at least the conditions are established that make the pursuit of the final effect binding, as the best.

The many potential advantages when combining SCA and ANP, with respect to the traditional approaches, are reported in Table 1.

In parallel to the reasoning developed with respect to the Latour cycle, a review was conducted in the OR literature on multi-methodologies composed of PSMs and MCDAs. The most interesting paper identified was Marttunen et al. (2017), which illustrates a literature review of eight PSMs and seven MCDA methods. The paper analyzes articles published in the period 2000–2015, then proposes a selection of 68 that covers all PSM-MCDA combinations in different fields of application. This literature review found that the PSM methods most used in combination with MCDA are SWOT analysis and Scenario Planning (Marttunen et al., 2017). Moreover, the paper notes that AHP (Analytic Hierarchy Process) and ANP have been combined most with PSMs, even if there were no combinations among ANP and SSM (Soft Systems Methodology), SODA (Strategic Options Development and Analysis), and SCA—the most widely known problem structuring methodologies (Rosenhead & Mingers, 2001). As Marttunen et al. (2017) suggest, these methods are indeed broad and complex in their applications, and may be especially demanding for MCDA experts, given their different skills and perspectives. It is thus likely that the small number of cases in the literature is indicative of these difficulties.

Starting from this picture, we brought the literature review on SCA and ANP combinations up to date. The database used was the Web of Science Core Collection (WoS). First, we chose the keywords for the research: "Strategic Choice Approach" and "Analytic Network Process," or "SCA" and "ANP." Second, the search was performed by topic, and the keywords were looked for in the title, abstract, and papers between 2015 and 2021. This search was performed in November 2021 and the database search returned 157 documents. All articles found were analyzed and filtered, and we were thus able to confirm that combined applications of SCA and ANP are not currently present in the literature, as far as we know.

Specifically, the application presented here combines the two methods in an integrated implementation—among the categorizations of Marttunen et al. (2017) as sequential, embedded, or integrated—since the combination moves from a more independent consideration of the two, in their specificities, to an integration in the analysis. The new multi-methodology is articulated in four main phases, as shown in Fig. 3.

4. The case study: repurposing a former hospital

4.1. Research setting

The potential use and value of the proposed multi-methodology are illustrated through a case study of the repurposing of the Civic

Table 1
The phases of the "collective" in parallel with the advantages in the proposed multi-methodology.

Phases	Emerging issues in the "collective"	Advantages in the multi-methodological approach
(i) perplexity: a problem emerges	When new "facts" and entities appear, a need emerges for those who debate a problem, having to deal with an uncertain status that asks to be considered and with new issues to be taken into account in the discussion	Problem structuring with SCA facilitates effective structuring of a problematic situation, rather than solving it directly; provides a rich representation of the problematic situation to enable effective analysis; and allows for an increased awareness about choices to be made
(ii) consultation: further elements are articulated	When new "values" and voices ask to participate in the articulation of the problem, a need emerges to define who "must sit in the arena," with an extension of the number of interested parties in the discussion	Option designing with SCA creates alternative schemes, accounting for different perspectives in a transparent way; facilitates a better understanding about the available alternatives for each choice; then a decision can be conceived once the problem has been better defined
(iii) hierarchy: an evaluation is proposed	The emerged "values" have to be confronted with the choices already made and the decisions already taken, with the arrangement of the new entities in terms of their compatibility and relative importance with the already established issues	Pairwise comparison through ANP helps to identify well-specified, complete, relevant, and operational evaluation criteria; facilitates evaluation of the alternatives in a transparent and systematic way; then an assessment of different alternatives according to multiple, conflicting perspectives is provided
(iv) institution: an agreement is reached	The emerged and discussed "facts" become legitimized, as evidence, and agreed, in terms of the new ordered and established entities	Defining a preferred solution through ANP reduces overload and complexity, aggregating multidimensional data; aggregates preferences across criteria; and provides a preferred alternative, instead of a commitment package to be further explored

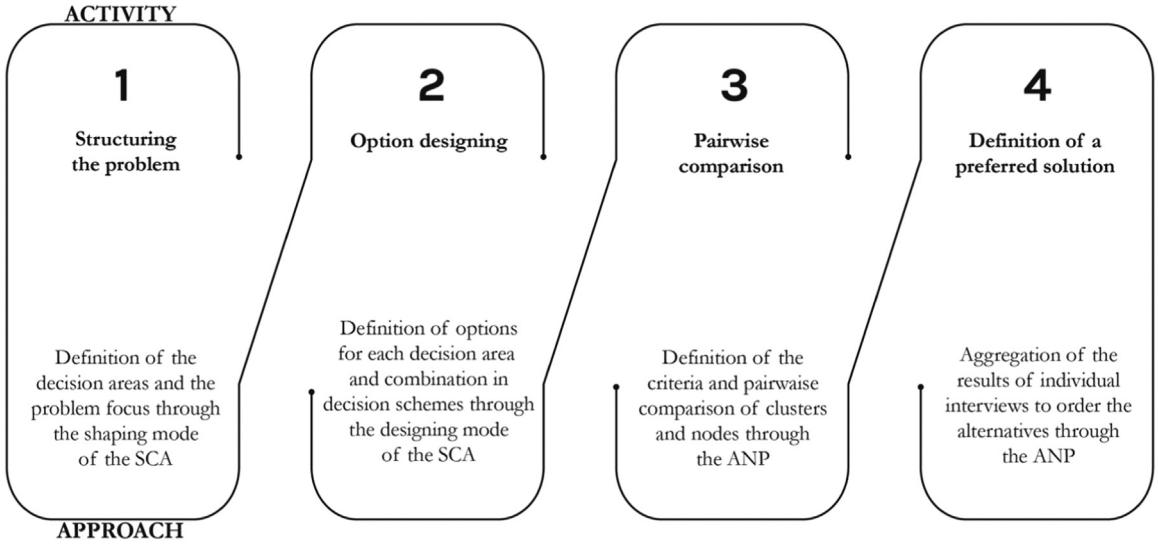


Fig. 3. Synthesis of the steps in the multi-methodological approach.

Hospital of Fermo, central Italy, where the method was used to compare and rank three alternative projects. This case study was chosen for several reasons as an illustration of the method's general applicability. First, it was a real-world planning and design decision which involves engagement with multiple decision makers (DMs), among which staff from the Health Authority (the owner of the property) and representatives of the Municipality of Fermo. Second, it was an example of a very common decision-making process of policy making in Europe, viz., how to regenerate underused public real estate assets (Németh & Langhorst, 2014).

The four stages of the multi-methodology (*Problem structuring with SCA*, *Option designing with SCA*, *Pairwise comparison through ANP*, *Defining a preferred solution through ANP*) were applied as described in Table 2.

4.2. A brief description of the context

The hospital to which the proposed method was applied was in the process of being taken out of service during the study. In recent years, national laws and decrees in Italy have drawn attention to the problems posed when buildings are no longer fit for their original purpose and, in the case of hospitals, have led to their closure and dismantling. Since hospital buildings are often located in large central areas of a city, closing them down involves several different architectural, social, and economic issues. Moreover, hospital buildings sometimes have considerable cultural and historic value for their city. In this sense, reusing them can make it possible to promote and open the areas in which they are located—often enclosed because of their original function—to the rest of the city. As there is no single way of dealing with these questions, decisions are usually made case by case by the parties who are directly involved in varying degrees with the asset. Accordingly, this kind of decision process requires qualitative and quantitative methodologies that can support the urban and territorial transformations from an integrated perspective (Abastante, Pensa & Masala, 2020; Bottero, Ferretti, Figueira, Greco & Roy, 2015). In view of a problem with these characteristics, for the application of ANP we were able to identify three types of criteria that consider a range of architectural, economic, and social aspects.

In the case of Fermo's hospital, a new program agreement was signed in 2016 because the National Health Authority mandated a functional reorganization of hospitals by hubs and spokes, depending on the level of complexity of care. Over the years, the Fermo hospital's structure changed due to continuous expansions and

Table 2
The main steps of the application.

Phases	Activity	DMs involved
SCA	Literature review on the topic of the adaptive reuse of former hospitals at the national level	–
	Interviews with DMs and stakeholders (from the Health Authority and the Municipality)	Two representatives from the technical staff of the Health Authority and three representatives from the Municipality (among which the Mayor)
	Definition of the decision areas and of the problem focus with the shaping mode	–
	Preliminary analyses based on similar case studies of adaptive reuse in the national context, current trend on possible functions to be proposed	–
	Proposals for hospital reuse discussed during the interviews with the DMs	Two representatives from the technical staff of the Health Authority and three representatives from the Municipality (among which the Mayor)
	Definition of the options for each decision areas	–
	Individuation of the incompatibilities among options and definition of feasible decision schemes	–
ANP	Definition of the cluster of the alternatives (based on SCA's decision scheme)	–
	Definition of the clusters of the criteria (based on relevant issues in SCA's decision areas)	–
	Definition of a single network model	–
	Pairwise comparison through interviews with DMs and stakeholders (from the Health Authority and the Municipality)	Two representatives from the technical staff of the Health Authority and three representatives from the Municipality (among which the Mayor)
	Aggregation of the answers	–
	Definition of the vector of final priorities, the final ordering of the alternatives, and the graphical ranking of preferability among the alternatives	–

annexations, while it also became more complex in organizational terms. Consequently, first a management problem emerged, given the need for expansion made impossible thanks to the dense fabric of the historic center in which the building is located. Second, changed needs, the obsolescence of technologies, and a problem of seismic adaptation (after the earthquake in central Italy in 2016)—which implied a non-convenient nor feasible demolishment and rebuilding—modified the problem. Third, if decommissioned, the transfer of hospital functions would thus create an urban void that could risk blighting the neighborhood and the entire city, whose historic center is already in need of renewal. Consequently, the application to the case study started with the emergence of a divestment problem, to be taken into account with the aim of providing a unique opportunity to rethink the area and revitalize the city and its surroundings.

4.3. Problem structuring and option designing with SCA

The analysis, whose overall objective was to identify a possible future for the hospital, began with the first two modes of SCA. This first macro-phase started with the shaping mode, where a set of decision areas reflecting all the decision problem's main concerns were identified: first of all, these regarded aspects related to the functions. The next level of discussion concerned the building's management and relationship with the outside; additional decision areas were related to the demolition or reuse of the buildings. As a new problem irrupted and influenced the involved parties in the problem and the process, several new entities appeared and needed to be considered in the discussion. In doing so, the shaping mode simultaneously enabled consideration of both actors (i.e., potential users of the building) and actants (i.e., functions that could be in the building) as the ones to be dealt with and to be structured for a better understanding of the situation's specific issues.

The spatial aspects were selected to be the problem focus, such as the decision areas *function*, *demolition*, *buildings*, and *territory*, to be further explored in the designing mode. As new voices asked to participate in the process, these further elements in the problem were articulated, in order to address the problem from different perspectives and build a shared view of the possible solutions as actions to solve the problem. Lastly, once the decision options were identified, the incompatibilities among them were determined, based on the preliminary analyses of similar case studies, and on the interviews, but also in terms of the surfaces needed for each function. Five alternative decision schemes—i.e., repurposing scenarios consisting of feasible combinations of options from each decision area—were drawn up.

4.4. Hierarchizing alternatives with ANP

The third and fourth steps consisted in applying ANP to identify criteria to evaluate the alternative scenarios and define the preferred solution. Starting from the problem focus designed through SCA, three of the five decision schemes were selected (Fig. 4) based on the intention to pursue a strategy of conserving and enhancing the existing asset, which could be investigated and evaluated as a way of narrowing the alternatives. Consequently, the decision schemes that called for new construction were ruled out.

The decision schemes developed with SCA were then designated as nodes in the "cluster of alternatives"—labeled according to their main function as "Museum," "University," and "Health Functions."

After defining the alternatives, the clusters of criteria and the respective nodes were identified (Table 3), based on relevant issues that already emerged in SCA's decision areas, on the basis of which evaluating the alternatives to find the most suitable project for reusing the building could proceed. Twelve nodes resulted, grouped in three clusters, distinguished by theme. Specifically, four nodes were identified for the "Architectural and Urban Issues" cluster, related to the valorization of the area and buildings, and to the improvement in quality of the neighborhood and the city. The cluster "Economic Issues" included five nodes, among which the costs of construction, management, and the ability of the work to be self-sustaining and produce economic wealth in the city. The last cluster, "Social Issues," considered the potentialities and the social and city-wide repercussions of the transformation of the area.

After decomposing the problem, the relationships between the clusters were defined as a single network model, in which all the elements of the clusters of criteria influenced the alternatives, and all alternatives influenced the elements of the network. To rank the three alternatives, a questionnaire was prepared and administered during interviews with decision makers and stakeholders.

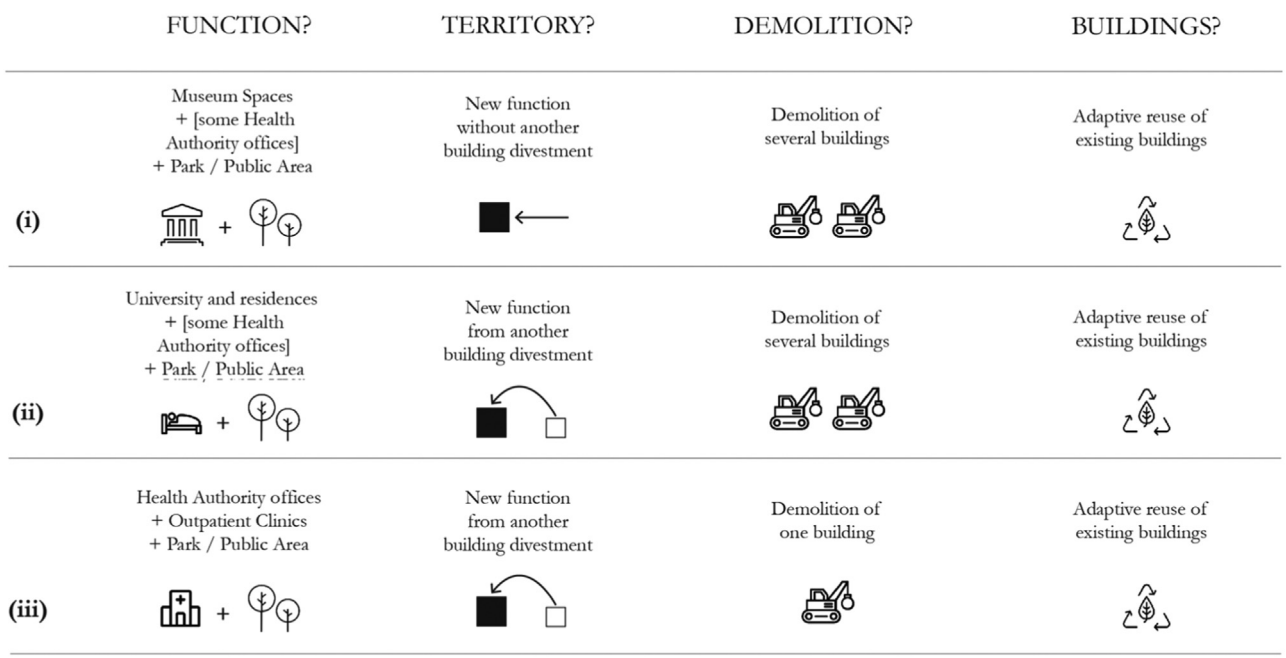


Fig. 4. A selection of three of the five decision schemes identified through SCA.

Table 3
The three clusters of criteria and their nodes.

Cluster	Node	Description
Architectural and Urban Issues	More green area	Recovery and transformation of the areas after demolition
	Enhancement and reuse of buildings	The transformation is consistent with the history and architectural conformation of the existing buildings
	City landmark	The transformation of the area and the new functions will be significant at an urban level for the city
	Improved local mobility	New city traffic and pedestrian routes
Economic Issues	Economic development of the city and local area	The site can become a hub influencing the development of the city and its surroundings
	Construction costs	Costs of demolition, adaptation, and construction
	Construction times	Project implementation period
	Management costs	Management costs during the operation of the activity
	Self-sustaining capacity	Activities that may need implementation funds but should be able to ensure self-sufficiency
Social Issues	Meeting point with new public services	A hub for new functions for townspeople and residents in the surrounding area
	Social mix in a predominantly residential area	New functions will draw people to the area with whom the resident population will come into contact
	Reduced interest in other places	Shift attention to the new hub, reducing interest in other places

The meetings and questionnaires in this phase were extremely interesting, as they permitted evaluation by the experts who were actually involved in the repurposing project. Five representatives of the Health Authority (two people) and the Municipality of Fermo (three people) were interviewed one-on-one and first asked to give a weight using Saaty's scale for the comparison between clusters with respect to specific parameters. The judgments at this stage showed that the choice between alternatives was influenced mainly by the social aspects, followed by the architectural, then urban and economic.

The questionnaires then proceeded to pairwise comparisons at the node level. After evaluating the five questionnaires and the 60 comparisons, the individual answers for each question were aggregated to determine which alternative was preferred overall, through a "majoritarian" aggregation method (Lami, Abastante, Bottero, Masala & Pensa, 2014), giving the priority vectors. The set of priority vectors from each comparison composes the initial unweighted supermatrix; then, through the weighted supermatrix, priorities that emerged from the pairwise comparison at the cluster level were considered. Finally, the limit supermatrix allows for the vector of the final priorities of each element present in the decision network to be obtained. The final ranking of the alternatives indicated as the preferred scenario the realization of a university, with residences and park/public areas, with a score of 55% (Table 4).

5. Discussion

Based on the findings of the case study it is possible to observe in greater detail the advantages of the multi-methodological approach (Fig. 5), framed in the "collective" phases as designed by Latour (2004) and interpreted by Armando and Durbiano (2017).

SCA allows actions of detection through the shaping mode (Friend & Hickling, 1987, 2005; Gomes Júnior & Schramm, 2021; Smith & Shaw, 2019). The set of decision areas enables consideration of the main concerns that the irruption of a new problem implies and makes them visible: through the shaping mode, it is possible to have a clearer representation of the problematic situation. Functions, management issues, spatial aspects, users, money, all these aspects are linked together and visualized in their

Table 4
The final ranking of the alternatives.

Alternatives	Description	Priority	Normal	Ideal	Ranking	Percentage
1	Museum spaces + some Health Authority offices + Park / Public area	0.13	0.29	0.53	2	29%
2	University and residences + some Health Authority offices + Park / Public area	0.24	0.55	1.00	1	55%
3	Health Authority offices + Outpatient clinics + Park / Public area	0.08	0.16	0.28	3	16%

relationships in order to be tackled. The set of option schemes, built through an articulation of alternative scenarios, is a way of considering and exploring different possibilities to be discussed, and the consideration of incompatibilities allows explorations to be directed only into reliable and feasible directions, not arbitrarily, but considering relations among the above-mentioned concerns made visible (functions, users, money).

In the case study described here, for example, the first decision area identified concerned the functions that could be located in the building (*function*); then, in a sequence reflecting the design thought process, further related and interconnected decision areas were identified (viz., *number* and *percentage*). In this sense, the shaping mode structures the problem in terms of a set of interconnected decision areas that emerge when unpacking the main problem and thus provides an organized way of thinking about a problematic situation. The designing mode in SCA can then be framed as a phase of scenario building when the problem is articulated and structured so that it can be fully understood (Fig. 5). A set of decision options is identified, and feasible combinations of these options are developed as possible alternative scenarios. As regards the repurposing strategies (*buildings*), for instance, one option consisted of constructing some new buildings and adaptively reusing others, while another consisted only of the adaptive reuse of the existing buildings. These two alternatives envisage very different types of repurposing and entail a variety of scenarios that may result from a new problem, thus detecting entities that have not yet been considered, together with their consequences and implications.

After SCA has been used to provide a structured view of the problem and identify alternative scenarios, ANP can be applied with a series of defined criteria. Network creation and pairwise comparison enable measurement and evaluation of different alternatives (Fig. 5), scoring each alternative and defining rankings, against a coherent set of criteria (Mu, Cooper & Peasley, 2020; Saaty, 2005; Saaty & Vargas, 2006; Witt et al., 2020). The definition of the alternatives and the criteria, through which it is possible to discuss with the main involved actors, allows the alternative scenarios to relate with the reality "already there" and with respect to each other, in terms of compatibilities and contradictions. This is the moment in which preferences, choices, and evaluation are actually carried out, "in public" and with the many interested involved, and the identified and articulated possibilities (combining actants and actors in scenarios) are assessed to find an overall hierarchy. The definition of the priority vectors, the superma-

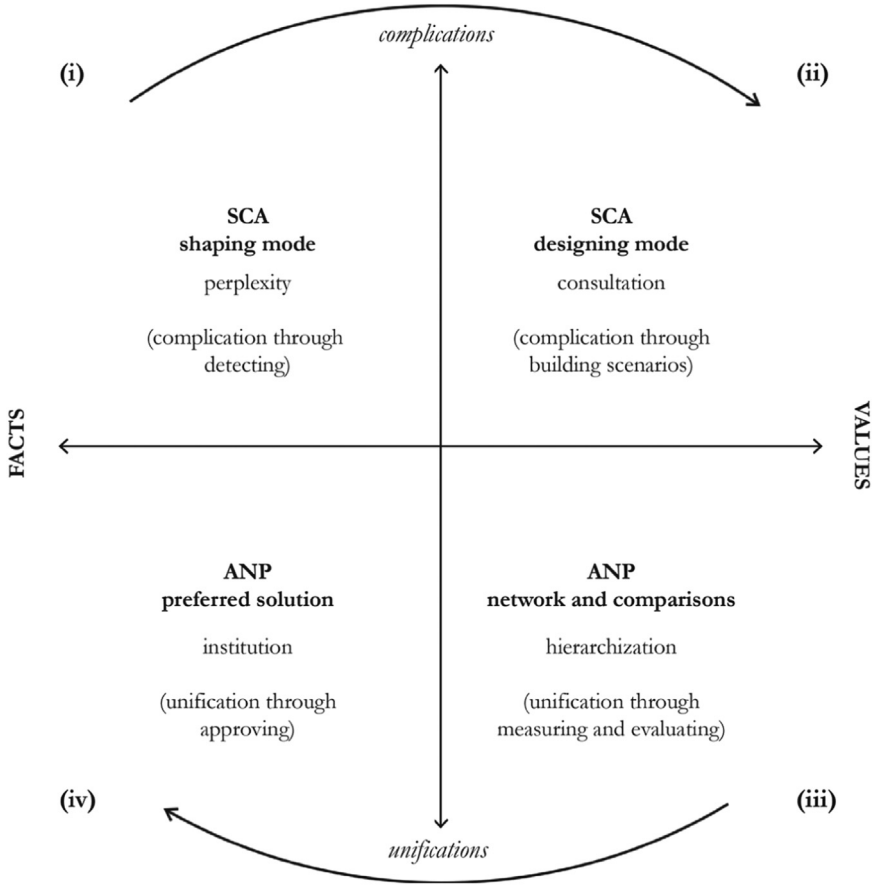


Fig. 5. The advantages of the multi-methodological approach, framed in the "collective" phases.

trices, and the vector of the final priorities allow the process until that point—in terms of clear and shared "figures"—to be to fixed and stabilized, synthesizing the comparisons, the preferences, etc. through a clear and reliable definition. The closure is made possible by actually having a clear definition of rankings and scoring that make up an understandable and shareable base on which to define a choice. The purpose is debating to provide an understanding of how choices influence each other, and what changes and improvements they can bring.

In the case study, for example, the pairwise comparisons indicated that the Museum alternative was less suitable than the University alternative, since the city was already engaged in converting former college facilities and other buildings into exhibition spaces. Lastly, ANP lead to a choice and closed with approval when a preferred alternative was found. Here, the results were stated in terms of a percentage preference for each alternative and, as mentioned earlier, the University scored 55%. This means that the preferred solution was clear, as was the choices' relative position. The University alternative involves many aspects of general interest, since a young population in the city, in addition to creating new economic flows, would enrich society. Moreover, the almost continuous occupation of the spaces would ensure that area businesses can survive and grow. Lastly, this enhances the architectural complex in terms of adaptive reuse strategies and sustainability. These clear criteria lay down the conditions for achieving the final effect, establishing which scenario is best.

6. Conclusions

The paper presents a new multi-methodological framework combining a PSM and an MCDA as a way of tackling complex socio-technical phenomena. To develop a theoretical model in combining two methods, we proposed to introduce an extended conception of ANT, already present in the OR debate, suggesting Latour's concept of the "collective". We may state, along with Latour, that there are no "separate chambers" in which facts (the use of public resources, different time horizons) and values (the values of different actors, legitimacy) are discussed; rather, by considering all these aspects together in a cycle that encompasses them, we propose a multi-methodology combining SCA and ANP which, as far as we know, is absent in the literature.

On the one hand, SCA enables detection of relevant issues in the decision problems and their articulation in alternatives; on the other hand, the integration with ANP allows hierarchization of alternatives in an aggregated evaluation and, in so doing, discussion of the problem to be faced in a more transparent—and more structured—manner. We suggest that SCA can help to meet "the requirement of external reality" and "the requirement of relevance," while ANP can help to meet "the requirement of publicity" and "the requirement of closure." In fact, SCA can make significant contributions to problem structuring—addressing the decision problem through several steps and the associated forms of representation—while the priorities among options are defined in general and qualitative terms. Problem structuring is crucial to success in applying ANP, since the specific structure is the basis on which the criteria and objectives of the comparison are determined. In this sense, option prioritization is the fundamental output that enables the method to determine which alternative is best. We believe that combining SCA and ANP has the potential for emphasizing the advantages of each method in an integrated practice.

Our study had some limitations that can be addressed through future research.

First, we note that using SCA together with ANP is only one of many possible combinations. As our research started from SCA and sought to find ways of enhancing it in combination with MCDA, we recognize that the choice of this particular MCDA may not be the most suitable. While we acknowledge ANP's great value for pairwise comparison because it can be readily applied with DMs in real-world settings, we are fully aware of the extensive debate in the literature about its limitations. We admit that colleagues in the field of MCDA research are likely to dispute certain aspects of ANP, but we welcome the debate as an opportunity to improve the comparison phase in order to contribute effectively to methodology development. Moreover, in order to strengthen the discussion on the indicated outcomes, a sensitivity analysis—not further developed in this case—would have provided more insights in terms of robustness of the outcomes, which could be stressed further in later applications.

Second, although we applied our new multi-methodology to a real case with interaction with real DMs, the approach was not actually used in the decision-making process that led to the choice of which transformation to implement on the hospital investigated here. We acknowledge that better external validity, reproduction of organizational life, and the inherent complexity and uncertainty would have been achieved within an effective decision-making process.

Finally, we recognize that the model suggested for supporting the decision-making process of policy making has been applied here to a specific context, that of urban transformations, which limits the generalizability of the findings.

Notwithstanding these limitations, there is considerable potential for further research. First, since the contribution of PSMs builds proceduralities that allow decision-making actions to be measured and compared, communicable and justifiable, we call for more studies investigating the contribution of Latour's cycle to reflect on which methodologies best respond to irruptions, integrating them into the decision-making process. We chose to combine SCA and ANP, but it would be interesting to test other combinations in this specific perspective. Second, it may be fruitful to further investigate the utility of this new framework in other policy making contexts, where it could show its potential in helping policy makers to shift reflection to other "matters of concern," capable of disruptive, often unexpected, and uncontrollable consequences.

Similar research on the use of different PSMs and MCDA for tackling different problem situations and contemporary challenges will contribute to formulate generalizations about the use of a multi-methodology as a circular process—from "facts" to "values" and vice versa—in which the problem emerges, followed by needs to be recognized and articulated, evaluated and measured, prior to building orders of priority, which can then be instituted.

Declaration of Competing Interest

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ejor.2022.10.029.

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