

Public Participation with Fuzzy Cognitive Maps to Assess Safety Perception in Urban Regeneration

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Abstract. In urban regeneration it is essential to promote civic engagement through public participatory processes because stakeholder involvement ensures democracy, legitimacy and effectiveness of decisions. Nevertheless, this entails dealing with a mass of fragmented qualitative information which, in the case of the public's perception of safety, is intangible, uncertain and ambiguous. Experts need supportive methods to process this in order to make it more understandable and manageable. This paper discusses the work conducted in a case study of urban regeneration of a degraded, historical central square in the city of Bari (Italy). It presents a process designed with Scenario Workshop consultations and conducted by leveraging the Fuzzy Cognitive Map approach to model shared knowledge. This aimed to achieve a collaborative problem-solving decision-making environment to address differing intentions in situations where means and ends are confused. The development of what-if intervention scenarios enabled the evaluation of counter-intuitive cause-effect links, the recognition of critical causal loops and unintended consequences and the identification of feasible choices. The results demonstrate the suitability of the proposed process as a decision support system in the field of urban policy making to facilitate learning and negotiation, allowing for innovative solutions to emerge and for the empowerment of local communities.

Keywords: Fuzzy Cognitive Maps · Participatory process · Urban regeneration · Decision support system · Public policy making · Urban safety perception

1 Introduction

Safety and its perception from the point of view of citizens is a key theme in assessing the liveability of cities and is an increasingly significant factor in urban planning choices. The interaction between a social system and that of a city's spatial urban-architecture influences, by fostering or hindering, the perception of threats and consequently the need for greater safety. In order to obtain effective urban regeneration, analytical methods must be applied which are able to take into account the complexity of intangible elements such as those that are psycho-social or cognitive and related to the shared perception of danger. These approaches reveal how these elements can be assessed and integrated

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with the technical analysis of physical features to provide effective support in operation and management decisions.

Given this background, this study investigates the perception of safety in public areas, considering the combined effect of both social aspects and the built environment, for the case study of the historic Piazza Umberto square in Bari (Italy). It was developed through the public participatory process headed by researchers from the Polytechnic University of Bari in 2019. This procedure involved focus groups on thematic issues aimed towards blending knowledge from the local community, institutions and experts. The choice of this case study was based on the opportunity to regenerate the area of the square and restore its public use. Indeed, despite its central location and its historical value, the area had become notorious as an unsafe place to avoid, given its degraded state. The purpose of this paper is to present the proposed participatory process, along with the methodology to structure shared knowledge and also to evaluate to what extent this was able to make the perception of safety, an intangible aspect, more definite. The method used to formalize collected opinions is described; these were modelled with a process based on fuzzy logic, i.e. Fuzzy Cognitive Maps (FCM), with Mental Modeler (MM) software [1]. Subsequently, hypothesized intervention choices were simulated within what-if scenarios to support decision management for urban planning and to verify that their effects met people's requests [2].

Although limited by a tight schedule, the results obtained were of great interest. The FCMs were able to visually represent people's thoughts and it was possible to express the ambiguity and uncertainty inherent in multi-agent spatial systems [3]. The developed approach proved to be suitable as a method for problem structuring and formalization, since it generates useful knowledge to support public decision-making. The creation of what-if intervention scenarios gave us the opportunity to visualize the cascade impacts of decisions aimed toward increasing the perceived safety of users and, at the same time, allowed us to verify the effectiveness of the FCM approach. Indeed, the dynamic elaboration of FCMs was useful in identifying possible unintended consequences of choices to plan mitigation strategies in advance.

The paper is structured as follows: following the introduction, a background section links the study to the participatory process practices and explains the FCM approach within the framework of problem-structuring methods. The following section presents the case study. Subsequently, the methodology for data acquisition and analysis in the context of the participatory workshop is described. This is followed by an analysis of the thematic map representing the what-if scenario of safety and a discussion on findings. A concluding paragraph reports limitations and recommendations with considerations on the potential of the proposed approach and future developments of the work.

2 Background

In land use planning, problems are ambiguous and must be understood from fragmented information about situations in which the means and ends are confusing and contradictory [4]. Thanks to public consultation, critical issues are identified through interaction between different stakeholders and no longer by examining solely urban and regulatory aspects. Participatory processes are a way of informing, listening, assessing and making

decisions which allow the knowledge process to be extended to non-rational components [5]. The choice of how to structure these and the methods for formalizing information and results is a consequence of the evaluation of elements such as the territorial scale, the purpose of the process, the number of participants and the resources available. In this work, a Scenario Workshop (SW) approach integrated with information structuring and analysis using Fuzzy Cognitive Maps (FCM) is adopted. The SW was applied as a public consultative method, implemented in the presence of a limited number of problem-aware/participants, on a specific issue with a strong local impact and for the prior assessment of the consequences of choices. This served to examine and contextualize the problem, hypothesize related issues and identify combined patterns of solutions through concrete actions applicable at topical moments of change [6]. A technique for formalizing information was essential to facilitate communication and consensus among stakeholders and to inform later public debate. Problem-structuring methods map the nature of the situation to be changed by modelling the knowledge of stakeholders to create a formal, shared representation of reality and develop new understanding. In this field, FCMs are a parameterized form of concept mapping in which it is possible to transform qualitative static models, for example, environmental, social or ecological concepts, into dynamic and semi-quantitative ones. These can be visualized in the form of a matrix or graph [7]. In this case, the FCM analysis method was developed to describe the problem, the solutions based on the proposed actions and their mutual impacts. A cognitive map (CM) (also called mental map) is an adaptable graphical representation of perception on a particular topic [8]. Graphically, it is a network of nodes connected with arrows, where the direction of the arrow implies the assigned causality. It can be used to encode, store, acquire, transmit and decode information about a phenomenon, as well as a specific and spatially defined environmental problem. However, the CM, while able to represent the mutual influences between the elements of a system, is not able to express the ambiguity of causal relationships typical of complex social systems. Therefore, its integration with the theory of fuzzy logic is designed to overcome this limit. Kosko introduces FCMs to make CMs more flexible and appropriate for the more vague knowledge systems and uncertain reasoning that reflect real-world case studies [9]. Indeed, fuzzy logic was developed as an extension of dual logic to deal with real-world problems in which the absence of defined classification criteria is a source of uncertainty [10]. This is a multi-valued logic, since the true and false values of bivalent logic become the extremes of a continuous domain. With this principle, it is possible to analyse an uncertain (fuzzy) set and estimate partial membership of elements in that set. Thus, while in traditional logic the degree to which an element belongs to a set is expressed in binary terms (i.e. an element belongs to it or not), with fuzzy logic the degree of belonging is within an interval ranging from 0 to 1. FCM consists of nodes and arcs where the nodes represent concepts and the arcs represent the causal influences between them. The centrality value of each node reflects the role of the concept itself in the network. The relationships between concepts are expressed by positive or negative signs and with a weight for the influence value expressed with fuzzy values between -1 and 1 [11].

FCMs are widely used to support group decision-making processes where it is necessary to consider and integrate the knowledge of experienced and non-experienced actors. In the field of urban planning, FCMs are considered suitable tools to graphically represent stakeholder concepts such as issues, policies, priority events and core values. An FCM dynamic analysis leads to insights about the system in question, particularly predictions about future states that are not possible with statistical methodologies [12]. Specifically, FCMs help predict the evolution of the system to which they are applied by simulating its behaviour with a causal progression that answers what-if questions. In practice, once an FCM of a certain problem domain has been realized, the answer of the system to set up conditions can be simulated in order to test the evolution of impacts and support public debate and decision-making. In the present study, the FCMs were modelled using Mental Modeler software, which made it possible to parameterize the relationships between the components and develop and analyse thematic what-if scenarios created on identified criticalities and needs.

3 Case Study

The city of Bari is located in the south of Italy and covers about 116 km^2. The original nucleus of the city is today's old town. 1813 saw expansion outside the defensive walls that encircled it and in 1816 Joachim Murat issued a decree to construct the "new town", now the Murattiano district, with an orthogonal grid. Here, numerous buildings are protected, given their historical and architectural value. The present study refers to the redevelopment of the historical Piazza Umberto I and of the Goccia del Latte building located inside it (see Fig. 1). Piazza Umberto I is located in the heart of the Murat district, in a strategic position between the pole of the railway station (1865) and the main axis of Via Sparano. This is a non-fenced square with a public garden resulting from the merging of two previous gardens. The older of these was designed in 1866 by the Neapolitan architect Giovanni Castelli, together with the university building Palazzo dell'Ateneo and as part of its property. The second took shape in a later period as a scenic setting for the equestrian statue of Umberto I, a tribute to the assassinated Italian king, which was inaugurated in 1905. The garden still retains its original architectural setting, with pedestrian paths that wind through flower beds bordered by low brick fences, where the paths define a more or less regular grid, typical of Italian architecture. Upon completion of the construction of the Apulian Aqueduct, a large fountain with an oval basin was installed at the axis of the main University entrance. Inside the garden there is a small pavilion in Art Nouveau style. This building originally housed Caffè Umberto and in 1921 became the headquarters of the association Goccia di Latte and Maternal Assistance until the 1970s. This carried out charity work in favour of disadvantaged children. Currently, the building is a municipal property. After a long period of abandonment followed by recent renovation, it was entrusted to the FIDAS blood donation association.



Fig. 1. Area under study: Piazza Umberto square - red, train station - yellow, university - blue, Via Sparano - pink and on the right the Goccia del Latte building. (Color figure online)

4 Methodology

To provide an analysis of safety perception, an integrated path was designed and proposed. This was based on the active involvement of stakeholders to identify socio-economic and organizational measures, as well as any interventions on the built physical, functional and managerial environment. The methodology to formalize collective knowledge supported the participatory process through the development of what-if scenarios. This allowed us to analyse the demand for safety according to a process whereby the participatory identification of the nodal criteria of the problem leads to a definition of a decision support framework. This was carried out through an evaluation of the effects of actions which aimed to improve the liveability of the square and acted at the same time on the perception of risk, the sense of belonging and the role of informal citizen control. The developed approach allowed for the combined analysis of the configuration and usability of public space, with the aim of introducing elements of detailed knowledge into tools for administrative management to support the adaptation of places over time to satisfactory levels of safety, mitigating factors of danger. The design process consisted of five phases. The present paper refers to the first three of these which have already been carried out and are presented here for the case study. These phases were implemented with the support of the FCM method to structure problems and with a

Table 1. Design process for information collection, elaboration and analysis

Objectives of the process phase	Operational phases
Shared problem formulation	Knowledge Structuring with FCM
Generation of alternative redevelopment visions	Thematic map definition and elaboration
Actionable solution identification	What-if scenario analysis to identify priorities
Resulting choice-set collective validation and assessment	Shared problem formulation and building criteria to assess fulfilment of objectives
Decision support	Recommendation, formalization and integration with technical analysis

variable involvement of domain experts. Table 1 relates objectives identified within the participatory decision-making process to the operational phases of the project.

4.1 Knowledge Structuring with FCM

Stakeholder involvement was conducted during two meetings attended by several associations, public administrators and citizens interested in the redevelopment of the square, the building and the surrounding area; they were asked to share their knowledge and their views and ideas. Clearly the limited number of/participants was not enough to represent a large, democratic consultation. Indeed, the aim of the process was more aimed towards the creation of a collaborative environment where a wide variety of selected stakeholder types could share/well informed knowledge which could be elaborated publicly. Interesting physical and social issues emerged from the discussion, as well as numerous factors that influenced them. It was unanimously recognized that the square was an unsafe place due to the presence of criminal activities, such as drug dealing, fights and vandalism and the widespread state of physical neglect (see Fig. 2). In addition, the importance of intervention for regeneration as part of a broader and coherent district redevelopment was stressed. Nevertheless, despite substantial agreement on the most pressing problems, disagreements on and opposition to suggested solutions followed. This common situation reveals brainstorming deficiency as an effective method for generating alternative solutions, so confirming the need for a formalized expert-driven process for the comparison of choices and the identification of satisfactory and shared solutions.



Fig. 2. Scenario workshop with citizens and evidence of Piazza Umberto I degradation.

For this phase of the participation process an innovative methodology was triggered, with the aim of organizing, processing and visualizing contributions collected during the workshops. The construction of FCMs was based on elicited knowledge with the aim of obtaining a structured and tractable picture of the reality shared by stakeholders, experts and non-experts, through which more clearly salient features of the system and

nodal problems could be identified and possible alternative scenarios compared [13]. Hence, Mental Modeler software was used to create the map of concepts brought up by stakeholders during the debate. These were later grouped for reasons of clarity into three distinct classes of components: reference principles for redevelopment, critical elements that emerged from the analysis of the current situation and proposed possible solutions and their mutual impacts (see Fig. 3). Influences are depicted with links between components and quantified with fuzzy values, varying in a continuum between − 1 and 1, depending on whether the influence is negative or positive.

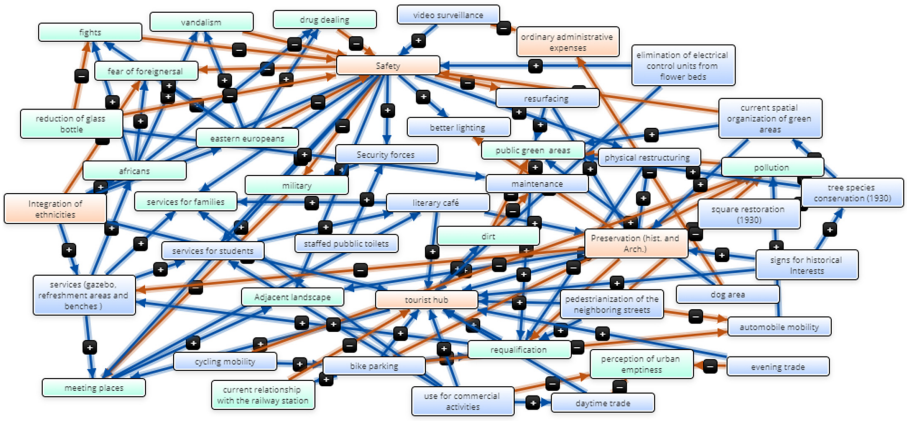

Fig. 3. Fuzzy Cognitive Map drawn up during the workshop.

In the accurate representation of knowledge that emerged from focus groups, the critical issues identified act as inputs to the system. Through the suggested actions these influence the guiding principles for the redevelopment of the area, which in turn play the role of outputs, i.e. effects derived from a certain combination of actions. In the map it is possible to follow the path of impact of each action on the principles to which it is connected. Moreover, those that influence several principles at the same time are crucial in the analysis and are called transitional, since they correlate different visions of redevelopment [14]. Nevertheless, the accurate representation made with the main map of the state of knowledge on the context and its problems is not particularly useful since it does not allow for the addition of new knowledge; consequently, thematic maps were created.

4.2 Thematic Map Elaboration

In the main map, it is not easy to speculate on exemplary future scenarios that enhance one vision of interest over the others and consequently this does not allow us to derive priorities for actions to be implemented. Thematic maps, centred on detailed scenarios of interest, were extracted from the main map with the objective of identifying the set of actions needed to achieve a single guiding principle. These new maps have a leading vision for redevelopment as a starting node that serves as a system input and nodes

and links to related actions and criticalities are also contemplated. Thus, because of the implemented reversal of the causal link, actions in the thematic maps become the effects of the scenario. In addition to the proposed solutions, isolated concepts and above all transition elements were identified in the map. In the present study the map developed to simulate the scenario on the theme of safety is shown. This is intended as the perception of being able to enjoy a functional area freely and peacefully, without risk or fear of feeling in danger of violence or crime (see Fig. 4).

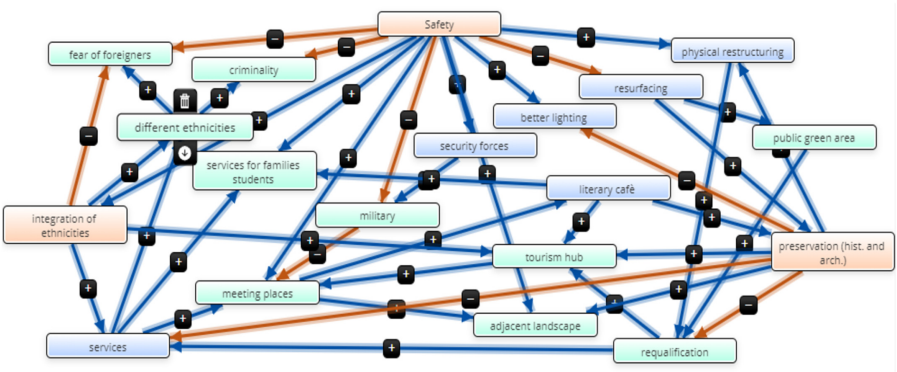

Fig. 4. FCM of safety perception scenario: principles - orange, criticalities - green and actions - blue. (Color figure online)

4.3 What-If Scenario Analysis

Once the thematic map was created, the scenario analysis was conducted according to hypothetical what-if configurations, each consisting of specific starting combination values of system factors. Subsequent inferences were automatically generated by software. This simulated the reaction of the system to various possible imposed conditions. Thanks to this kind of modelling, the real situation develops according to different paths. Indeed, the analysis does not examine a single image of the future but is expressed in different future outcomes. The most interesting aspect is to try to validate (or refute) the starting hypotheses and support (or reject) the resulting decisions. In fact, for each configuration an attempt is made to suppose the range of upcoming results and forecast an understanding of what these mean. Subsequently, to test the hypotheses in the scenario interface, the scenario is activated simulating the effects that derived from decisions. The impact on the system is visualized with a histogram that indicates how components react. Specifically, it presents the variation of each component depending on the value imposed on others and according to the causal relationships defined in the mapping interface.

For the case under investigation, operating on the key theme of the map, i.e. safety, enables us to appreciate how the scenario dynamically reshapes, visualizing the impact that the driving element had on the transition actions and how these in turn act on other principles. This process allows us to detect emerging and counterintuitive effects

and it is possible to understand the impacts associated with possible changes and those responding to the greater number of needs that minimize undesired effects. Thus, it is easier to identify any side effects due to the impacts that a certain choice causes on other elements of the system and strategies can be developed to mitigate the negative effects so that more resilient choices can be implemented. Furthermore, this elaboration process trains experts to conceptualize the types of situations that arise from the choices made, which will need to be managed in the future and for which they will need to plan ahead. Below a case is reported in which the weight assigned to the safety component (a value of each element of the map which transforms it from qualitative to quantitative) was increased to its maximum. This is to simulate combined impacts of this what-if configuration, as well as all the side effects on the system as a result of policies aimed at maximizing safety. Figure 5 shows the histogram produced by the software in the scenario interface. The graph represents how the components react to the assumption. Principles and actions are on the x axis, while on the y axis the returned variations are shown.

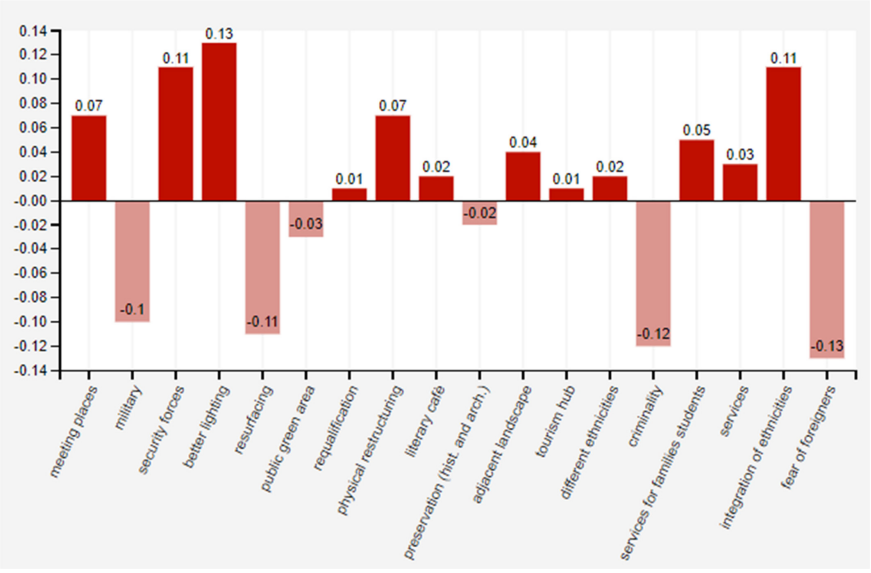

Fig. 5. Safety what-if scenario graph.

5 Results

An analysis of the histogram of safety scenario enables us to draw up a number of interesting evaluations. Indeed, in the plot of the scenario configuration in which the safety element is the main driver, elements aimed at restoring urban decorum have increased values. These aspects are related to the physical renovation of the square, better lighting and the resurfacing of paving and borders of flowerbeds, whereas the effect of the choice

to transform the Goccia Di Latte building into a literary café shows a minimal positive impact. The condition of decreasing public green areas is an unexpected collateral phenomenon because of its relative implicit reduction in the importance of the preservation of the historical and architectural heritage of the square. In addition, the scenario displays a growth in the social cohesion level due to the reduction of the perception of danger and also the increased possibility of using the square as a meeting place for students and families, while only a minimal positive secondary effect impact is evident on the cultural integration of different ethnic groups. Finally, the assumption that the prevention of crime (in particular predatory crime) can be achieved by reinforcing police control would imply more than simply increasing their presence, but a better distribution throughout the area with a view to reducing military presence. These minor variations demonstrate the reliability of the model in representing the complexity of the real system, in which the components, although connected through secondary effects, impact only slightly on each other because of the non-linearity of the interactions. The dynamic problem analysis assists in the development of decisions and measures for problem solving correlated with urban regeneration. In fact, in the later stages of the process, based on the outlined scenarios, an action guide in the form of a list of priorities and urgent measures will be compiled to develop management and intervention strategies.

6 Discussion

The collaborative decision-making process was designed since collaboratively dealing with divergent intentions and conflictual objectives is essential to facilitate negotiation in complex social environments. Moreover, this allows for innovative solutions to emerge [15]. Therefore, with the help of the FCM methodology from a stakeholders' engagement, an attempt was made to reach empowerment as much as possible. This was achieved by moving from a phase of information sharing and adding to this to reach active collaboration, following the layout in Table 2.

Table 2. Phases for participatory involvement.

Phase action	Description	Involvement Level
Inform	Inspiring, informing and supporting a learning process among stakeholders	Engagement
Consult	Actively listening to views, concerns and insights of others	↓
Collaborate	Working together to solve problems, drawing on expertise and knowledge of others	Empowerment

Although part of a highly specific environmental and urban context, characterized by non-polarized preferences and from a short-term project perspective, the results obtained are more structured and qualitatively better than the reports produced in traditional participatory workshops, or compared with those obtained from observations collected through public consultation activities. The proposed approach has proved satisfactory

in formalizing the problem, overcoming a linear cause-effect logic and managing the multiplicity of variables of interest at stake. In detail, the use of FCM to model and process the fragmented qualitative knowledge collected and the simulation of scenarios supported the process of reasoning and learning about causal loops and unintended consequences of choices.

From a methodological perspective, it is necessary to consider that in the modern practice of urban planning, the analytical phase of stakeholders' knowledge plays a central role. This is the result of the activities of collection and elaboration of information distributed among local actors. As a matter of fact, a meaningful description of an urban system requires the processing of a mass of data that a single individual can barely manage and understand. An expert can attempt to understand the relationships between two single factors in a complex system, or investigate how a certain factor affects others, but cannot understand the dynamic interaction of numerous elements all at once. Thus, structuring information with FCM was essential to make available data more manageable and to identify critical issues and feasible solutions. Nevertheless, due to the countless physical and socio-economic variables that come into play in urban situations, exact predictions are impossible. The scenario analysis applied is consistent with the need to obtain plausible projections to guide decision makers in defined context characterized by ambiguity, uncertainty and conflict. Indeed, the proposed approach addresses these complexities by incorporating multiple possibilities into the set of scenarios themselves. These will be used in forthcoming public debates to understand more clearly the complexity of the interdependence between possibilities, above all cases in which these alternatives are found to be incompatible. Thanks to this formalization, a more general shared reflection on the impossibility of reaching a single, unique and optimal solution can be developed. Conversely, a definition of a satisfactory trade-off between the multiple needs and priorities of stakeholders can arise.

7 Conclusion

In this paper the methodology designed to support the public participatory process developed for an urban regeneration programme is described. This was aimed at semi-quantitatively structuring the qualitative knowledge collected in meetings with stakeholders about perceived safety in the case of a defined, distinctive, but degraded public space in the heart of the city of Bari (Italy). It is shown how a traditional scenario workshop approach can be integrated by more innovative information processing with FCM formalized with MM software to elaborate collected data. This has the aim of addressing critical issues in terms of actual and perceived safety, encouraging the collective re-appropriation of places and promoting changes.

Every public policy is a strategic decision that aims to achieve defined goals in a certain time frame and this involves a set of linked elementary measures designed to address problems of a public nature. Stakeholder engagements on the decision-making process are necessary to avoid later conflicts, protests and resistance. Indeed, if involved, the decision phase can become much longer and non-linear, but it is a process that greatly facilitates subsequent implementation phases. As FCM uses a neutral approach, it can easily adapt to the context, mirroring this accurately. At the same time, it is

useful to focus attention on central and critical issues, as well as on pivotal solutions for transition. Moreover, as it fosters the creation of temporary and mixed groups, it helps to empower participants and build trust in the participatory process itself. Finally, the FCM approach ensures that both the participatory and decision-making processes at least partially overlap (where one usually precedes or follows the other). This is because the process involves discussion, choice and (after scenario development led by an expert) an analysis phase that endorses or refutes and modifies the outputs, with the aim of providing results that are immediately available for decision support.

Although the proposed process alone cannot fulfil the need for a large-scale, democratic public consultation, e.g. due to the limits of the sample size which can be managed due to the workshop nature of the meetings, it may represent an informed preliminary step. Indeed, in the near future, thematic scenario elaborations will guide a public debate with citizens to facilitate the understanding of causal links and the effects of desirable and undesirable choices, and thus to imagine more clearly the outcomes of the redevelopment of places. This will be used to define strategies and actions to make decisions more concrete, thus likely avoiding the risks of unintended consequences or implementing appropriate additions for their mitigation. However, prior to the goal of arriving at final shared decisions, public reprocessing of the results of the analysis is essential to build the process of collective learning, which in turn provides a larger number of stakeholders with access to more knowledge and so enables their empowerment.

The application of this approach for data analysis in the field of spatial planning offers promising opportunities for the study of complex environmental and territorial systems. It seems appropriate for building scenarios suitable for dealing with the kind of intuitive, nuanced knowledge that seeks to understand uncertainty rather than ignore it; this is an indispensable aspect of formulating effective strategies in today's multicultural and multifaceted cities and thus for public administration support. A limitation found in the approach is the inability to contemplate unknown future variables and thus the unexpected impacts of additional factors that may occur in the long term. For this reason, the FCM approach can be seen as a problem-oriented phase to evaluate possible solutions in contingent situations as part of a larger pathway aimed at building future development strategies. However, it is useful in narrowing the gap between research and practice and can make the added value produced by public participation quantifiable. The findings are extremely interesting, with significant potential in the field of urban governance to open new perspectives of applied research to support decision-making problems and urban public policy design.

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References

1. Gray, S.A., Gray, S., Cox, L.J., Henly-Shepard, S.: Mental modeler: a fuzzy-logic cognitive mapping modeling tool for adaptive environmental management. In: Proceedings of the Annual Hawaii International Conference on System Sciences, pp. 965–973 (2013). https://doi.org/10.1109/HICSS.2013.399

2. Borri, D., Camarda, D., Pluchinotta, I., Esposito, D.: Supporting environmental planning: knowledge management through fuzzy cognitive mapping. In: Luo, Y. (ed.) CDVE 2015. LNCS, vol. 9320, pp. 228–235. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-24132-6_29
3. Pluchinotta, I., Esposito, D., Camarda, D.: Fuzzy cognitive mapping to support multi-agent decisions in development of urban policymaking. Sustain. Cities Soc. **46**, 101402 (2019). https://doi.org/10.1016/j.scs.2018.12.030
4. Schön, D.: The Reflective Practitioner: How Professionals Think in Action (1993)
5. Nanz, P., Fritsche, M.: La partecipazione dei cittadini: un manuale. Metodi partecipativi: protagonisti, opportunita' e limiti, https://www.researchgate.net/publication/272418040_La_partecipazione_dei_cittadini_un_manuale_Metodi_partecipativi_protagonisti_opportunita%27_e_limiti. Accessed 07 Feb 2021
6. Barbanente, A., Khakee, A., Puglisi, M.: Scenario building for metropolitan Tunis. Futures **34**, 583–596 (2002). https://doi.org/10.1016/S0016-3287(02)00002-2
7. Eden, C.: Analyzing cognitive maps to help structure issues or problems. Eur. J. Oper. Res. **159**, 673–686 (2004). https://doi.org/10.1016/S0377-2217(03)00431-4
8. Tolman, E.C.: Cognitive maps in rats and men. Psychol. Rev. **55**, 189–208 (1948). https://doi.org/10.1037/h0061626
9. Kosko, B.: Fuzzy cognitive maps. Int. J. Man Mach. Stud. **24**, 65–75 (1986). https://doi.org/10.1016/S0020-7373(86)80040-2
10. Zimmermann, H.-J.: Fuzzy set theory. Wiley Interdiscip. Rev. Comput. Stat. **2**, 317–332 (2010). https://doi.org/10.1002/wics.82
11. Aguilar, J.: A survey about fuzzy cognitive maps papers (invited paper). Int. J. Comput. Cogn. **3**, 27–33 (2005)
12. Stach, W., Kurgan, L., Pedrycz, W.: Expert-based and computational methods for developing Fuzzy Cognitive maps. In: Studies in Fuzziness and Soft Computing, pp. 23–41. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-03220-2_2
13. Groumpos, P.P.: Fuzzy cognitive maps: basic theories and their application to complex systems. In: Studies in Fuzziness and Soft Computing, pp. 1–22. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-03220-2_1
14. Santoro, S., Esposito, D., Camarda, D., Borri, D.: A hybrid approach for the acquisition and analysis of distributed knowledge on spatial planning: the case study of the master plan for Brindisi (Italy). In: La Rosa, D., Privitera, R. (eds.) INPUT 2021. LNCE, vol. 146, pp. 195–204. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-68824-0_21
15. Giordano, R., Vurro, M.: Fuzzy cognitive map to support conflict analysis in drought management. In: Studies in Fuzziness and Soft Computing, pp. 403–425. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-03220-2_17