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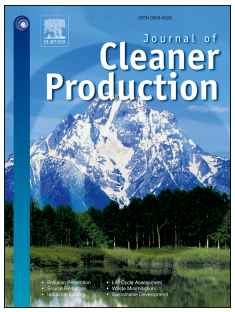

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Identifying Sustainability Communicators in Urban Regeneration: Integrating Individual and Relational Attributes

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Abstract

The paper advances a conceptualization of sustainability in urban regeneration as communicative practice taking place within networks of social actors. To demonstrate the potential of this perspective, we propose an interdisciplinary methodology integrating social network analysis from sociology and multi-criteria decision analysis (fuzzy logic) from operations research to calculate a sustainability communicator score for each actor involved in a regeneration network. The score is based on three dimensions: a sustainability vision (relying on the three pillar model of sustainability), a formal network influence dimension (based on organizational practice and decision-making position) and an informal network influence dimension (drawing on degree, betweenness, eigenvector and closeness centrality measures from social network analysis). The framework allows the identification and ranking of sustainability communicators, based on the preferences of specific users, while also allowing for variable degrees of vagueness. We illustrate the methodology by means of a case study of a social network of actors (N=28) involved in the sustainable regeneration of a brownfield site in Porto Marghera, Venice, Italy. The methodology is expandable beyond the actor level to allow for the ranking of more complex network configurations for promoting sustainability.

Keywords: sustainability, urban regeneration, social network analysis, fuzzy logic, sustainability communicators

Word count: 11744

1. Introduction

It is widely recognized today that the discourse on sustainability, whether global or local, is in some uneasy relationship with the practices of managing natural and human resources (Becker et al., 1999). Researchers concerned with the sustainability of urban regeneration have similarly noticed a persistent gap between the rhetoric of sustainable development and its real-life application (Dixon, 2006; Dixon et al., 2013). On the one hand, sustainability exists at the level of policy formulation, in which the rationales and aims of sustainable regeneration are stated in conceptual and policy terms (Nathanail, 2011). On the other hand, the actual regeneration practices and the sustainability outcomes of regeneration processes are under the influence of various contextual "structuring forces" such as economic imperatives, legislation and various government policies (Doak and Karadimitriou, 2007a).

Scholars have pointed out that the power of sustainability "lies in the discourses surrounding it, rather than in any shared substantive […] value it may have." (Redclift, 2007, p. 71). Other scholars have advanced a metatheoretical understanding of sustainability, in which communication and dialogue are seen as actual conditions of implementing social sustainability (Åhman, 2013).

In this article, we built on Åhman's insight and posit that between the rhetoric of sustainability and the reality of translating sustainability into practice there is a relational social space that connects discourse and practice but displays its own logic (Bodin et al., 2011). This space is inhabited by actor networks that are complex configurations of individuals and organizations that transform "ideas into concrete reality" (Cannone, 2009, p. 239) and "generate meaning which is then embodied into matter" (Doak and Karadimitriou, 2007a, p. 210). Actors do not act in a random fashion, however, but on the basis of practices of communication (Redclift, 2007, p. 73) by which actors seek to accomplish their goals. Goals and actor networks can thus be seen as the two components of the relational space in which sustainability is thought-out and worked-out by social actors.

Our goal is to open up the relational space of communicating sustainability to analytical scrutiny and quantification. This is important because it transforms our understanding of sustainability from being a property of stakeholders to its working as a process of persuasion. In the latter, each stakeholder is not an isolated bearer of a certain sustainability vision or discourse, but a communicator who can potentially convey that vision to others and persuade them to act in light of a certain discourse of sustainability. This approach offers thus an alternative way to promote sustainability in urban regeneration by means of social persuasion. The first step, which is undertaken in this paper, is to identify the stakeholders who can act as the most promising "persuaders" or what are called here sustainability communicators. Subsequent steps are to explore the communication ties, the configurations of sustainability communicators and the behavioural changes produced by communication, but these are the topics of future research.

The specific objective of the paper is to develop a methodological framework to identify and rank sustainability communicators within social networks. Since sustainable regeneration activities are carried out by actors embedded in social networks, we aim to identify those actors who endorse sustainability and are also influential within their regeneration networks. The latter seem to be best placed to communicate and potentially influence other actors to move towards sustainability in regeneration projects. The framework is developed based on social network analysis (SNA) and multi-criteria decision analysis, fuzzy logic in particular, and is illustrated via a case study.

Our study begins with a discussion of sustainability and briefly shows how this concept can be conceptually linked to networks of communication. The third section shows in detail the methodological steps involved in integrating SNA and fuzzy logic. The fourth section illustrates the results obtained with data from a case study of sustainable regeneration in Porto

Marghera, Venice, Italy, while the conclusions and possible ways forward are outlined in the final section.

2. Sustainability: From Discourse to Communication

It is nowadays a trite observation to remark on the conceptual fuzziness and often oxymoronic nature of the sustainability concept. There are vigorous efforts underway to critique and clarify the ideological undertones of sustainability at global (Redclift, 2007) and local levels (Lorr, 2012). Still, the concept continues to be employed and its users borrow from different sustainability discourses when articulating their development goals. While these discourses continue to be important in their own right (Åhman, 2013), researchers may gain a better understanding of what sustainability may mean in practice by looking at how it becomes an object of communication among actors. Before briefly sketching the theoretical background of this proposed concept, we review the current understandings of sustainability.

2.1 Contemporary understandings of sustainability

It has become common practice to discuss sustainability in operational terms, by distinguishing different themes or dimensions of sustainability. Littig and Grießler (2005) distinguish between one-pillar and three- or multi-pillar models. The former emphasize the ecological dimension of sustainability and subordinate economic and social goals to the need of making human society environmentally sustainable.

Multi-pillar models recognize the existence of sets of sustainability goals that need to be pursued simultaneously rather than competitively. For example, there are two alternative three-pillar models of sustainable development (Dixon, 2006). The first is the well-known "three pillar model" (Elkington, 1999, 1994) that assumes a balancing of economic performance, social justice and wellbeing and environmental protection (see Figure 1a). The second model is composed of the same three pillars, with the noteworthy difference that it also recognizes the environmental and social limits of economic growth (Dixon, 2006) (see Figure 1b).

Figure 1a. [Approximately here] *The three pillars of sustainability (focus on balance)*

Figure 1b. [Approximately here] *The three pillars of sustainability (focus on limits)*

There are, however, also sustainability models including four or even more dimensions. Omann and Spangenberg focus on the social pillar and add an institutional dimension to sustainability (2002), Stoilkov-Koneski (2015) underscores the importance of the social and cultural context, while Littig and Griessler (2005) include the cultural-aesthetic, religious-spiritual, or political-institutional pillars under the umbrella of sustainability. Scholars have therefore not limited their attention to the three pillar model, although this is still the most common conceptualization (Åhman, 2013).

The three pillar understanding of sustainability has also been adopted in brownfield remediation and regeneration research. Hou and Al-Tabbaa (2014) operationalize the three pillars for sustainable remediation by linking the environmental aspect to reducing the risk of harm from contamination and minimizing the secondary adverse effects of remediation and the economic pillar to the cost of remediation and also to the impact of site restoration on the surrounding economy. The authors acknowledge that the social pillar, including worker safety, community impacts, stakeholder engagement, public participation, environmental justice and social inclusion, has received the least attention in brownfield management (Hou and Al-Tabbaa, 2014).

Sustainable brownfield regeneration is defined in terms of the three pillars as "the management, rehabilitation and return to beneficial use of brownfields in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways" (Rescue, 2003). Nathanail (2011, p. 1085) distils from the work of CABERNET seven principles of effective (and potentially sustainable) regeneration which he labels as follows: "people matter", "places for people", "having a shared vision is vital", "there is no *I* in team", "build and they will come", "waste is a resource in the wrong place" and "leaders serve others now and in the future". With one exception, all these invoke the participation of stakeholders in one form or another.

It is common in the brownfield revitalisation literature to consider stakeholder involvement as one of the "vital [components] in sustainable development" (REVIT, 2007, p. 11). Sustainable development strategies that include stakeholder inputs and contributions are defined as a key requirement within several European research networks and projects (Cundy et al., 2013; Harclerode et al., 2015). The underlying expectation appears to be that by their involvement in regeneration, stakeholders will "bring to the table" (Doak and Karadimitriou, 2007a), and force the consideration of, a diversity of economic, social, environmental or institutional interests, that will make the process more robust and sustainable.

To conclude, sustainability scholars have achieved at least a partial consensus on the need to recognize the multiple pillars of sustainability, most often identified as the social, economic and environmental dimensions of sustainable development. At the same time, they have come to regard the involvement of stakeholders, having diverse needs, expectations and representations, as key in moving towards sustainability. We contend that further progress can be achieved by integrating the two and considering how different visions of sustainability (in terms of the three pillars) can be communicated among stakeholders jointly involved in regeneration practices.

2.2 *Sustainability as networked communicative practice in regeneration*

The concept of network has been increasingly used in the social sciences and in emergent cross-disciplinary fields to make sense of the complex relationships between space, matter and social structures in the process of (re)developing urban land (Doak and Karadimitriou, 2007b). Networks have been made responsible for both vicious and virtuous outcomes in the land redevelopment process.

An example of the former is found in the response of the development industry to the sustainability agenda in the UK (Dixon, 2006). In the particular case of sustainable buildings and energy efficiency, a "circle of blame" was observed. It connects different actors who shift the blame from one to the other: investors do not fund sustainable development because they perceive a lack of market demand, while those who would represent the demand (the users or occupiers) see themselves constrained in choosing sustainable buildings where to live. In turn, the constructors would build such buildings but place the blame on developers who do not ask for them. Finally, developers would press for sustainable development but assume in turn that investors would not pay for sustainability. The cycle thus repeats itself with each actor passing onto the next the responsibility for the non-sustainability of property redevelopment (Dixon, 2006).

There are also virtuous relationships, such as the channels identified by Hou and Al-Tabbaa (2014) through which site owners or managers, primary consultants, top management and regulators demand that remediation processes be sustainable. But the relationship between those who make sustainability requests and those who would act upon such requests is not always straightforward. For example, after asking whether sustainability has left any imprint on brownfield regeneration processes in the UK, Lombardi et al. (2011, p. 273)

observe that "documents guide, but people implement regeneration—and the disparate conceptualisations of stakeholders demonstrate even less coherence than policy".

There is a clear need for a unitary concept that can bridge the gap among actors involved in managing sustainability in urban regeneration processes. Based on recent theoretical advances in the land management literature (Doak and Karadimitriou, 2007a, 2007b), we propose the concept of social network and the notion of sustainability as networked communicative practice.

By definition, a "social network consists of a set of relations that apply to a set of social actors, as well as any additional information on those actors and relations" (Prell, 2011, p. 31). Communicative practice means that human understandings and values related to sustainability "are socially constructed through our communication with others and the collaborative work this involves" (Healey, 1996, p. 219).

The distinguishing characteristic of social networks is their relational character (Wasserman and Faust, 1994). Conceptualizing a research problem in social network terms means going beyond the characteristics of isolated individuals (such as age, profession, stakeholder category etc.) by taking into account how individuals (or other social entities) are related to each other (Emirbayer and Goodwin, 1994). Focusing on patterned relationships in addition to any other characteristics that individuals or groups may have, opens up a whole range of intriguing possibilities of conceptualizing human thought and action, including those related to sustainability. Scott (2014) summarizes the promise of analysing social networks in terms of their ability to identify and coordinate stakeholders, build knowledge via diffusion, allocate resources and include a diversity of voices in producing social and ecological sustainability[1].

The study of social networks – or social network analysis - is the exploration and measurement of how "resources, goods and information flow through particular configurations of social ties" (Bodin et al., 2011, p. 10). The terms used by brownfield remediation and regeneration researchers, such as "circles", "demands", "pressures" or "disparate conceptualizations", can be translated into the language of SNA.

The basic unit in SNA is not the individual but a structure composed of a set of individuals and the connections among them (Wasserman and Faust, 1994). The connections can be of different kinds, including similarities, social relations, interactions and flows (Borgatti et al., 2009). Each of these relationships can be investigated at multiple levels: at actor level, by looking at and comparing how each actor is connected to others; at network level, by describing the patterns that characterize the network as a whole irrespective of the positions of individual actors; and at subgroup level, where the question is whether there are certain subgroups who are more strongly interrelated internally than to the rest of the network (Prell, 2011).

All of the above concepts characterize the informal structure of a social network, namely the actually existing communication ties among actors. In a regeneration project, however, there are also formal relationships, for example between decision-makers and those who implement decisions. Both the informal and the formal aspects need to be taken into account when describing a social network.

This approach assumes that sustainability is subjectively interpreted by different actors (Mcalpine and Birnie, 2007) and, at the same time, that in any given group of stakeholders there is a substantial range of demands, goals and perceptions (Doak and Karadimitriou, 2007a) related to sustainability. Our aim is to use the concept of social networks to assess how sustainability can be communicated among actors involved in regeneration. The proposed framework includes the sustainability visions of actors and the formal and informal

[1] To stay true to Scott's contribution, it needs to be noted that he reviews the uses of SNA in relation to environmental governance and sustainability in order to develop a critique and alterative conception.

channels by which these visions can be communicated. We then assign sustainability communicator scores for each of the actors involved in a network and rank them in terms of their scores.

In this article, we choose to focus on one level (actor) and one kind of tie (communication). The individual actor is one of the most common levels of analysis in the SNA literature applied in environmental management (Bodin and Prell, 2011) and it parallels in methodological terms the widespread use of survey research on remediation and regeneration practitioners (Dixon, 2006; Hou and Al-Tabbaa, 2014). The score and resulting ranking of individual actors is certainly only one facet of sustainability as communicative practice in networks. By building on it, researchers and practitioners can unfold their imagination in constructing more elaborate integrative designs that would also take into account subgroups of actors or even whole networks (cf. Bodin and Crona, 2009, see chapters 9 to 13).

3. Methods

Based on the previous considerations, the framework for ranking sustainability communicators is built out of the following three dimensions: sustainability vision, formal network influence and informal network influence, as described in the sections below. Sustainability communicators need to be identified in terms of all three dimensions. The three dimensions are then integrated to develop a sustainability communication score for each actor in the network (see Figure 2).

Figure 2. [The updated figure 2 (5Aug2016) to be placed approximately here] *Sustainability communicator score assessment framework (user inputs allows for weights specified by the user).*

In order to collect data along all three dimensions, a survey-based research design is a convenient option, but other designs are also possible. We used an online survey to investigate the participants to a regeneration project taking place on a brownfield of Porto Marghera, Italy.

The case concerns an 8.8 ha large brownfield area (named Area 2), located in the first industrial zone of Porto Marghera. Area 2 belongs to the Venice Gateway Science and Technology Park (Vega STP). Following several remediation steps between 1998 and 2010, the redevelopment of Area 2 started in 2012 with the construction of the Expo Venice pavilion. The Expo Venice was the official side event of the Universal Exposition in Milan and its theme was “Water”. The pavilion is part of a wider process of urban and landscape regeneration known as the Venice Waterfront that aims to create a “multifunctional urban district” with two main towers that could become a “true landmark of the new urban landscape” by 2019 (Condotte, 2015). Following the post-industrial reconversion achieved by the Vega STP, this represents the first process of urban redevelopment taking place in Porto Marghera, one of the largest industrial areas in Europe. As such, this regeneration process is a rather typical case of brownfield-based urban development involving a wide range of stakeholders, eager to contribute to defining the new face of their city. In the Italian context, however, the case appears to be relatively novel as the envisioned use is not oriented towards service provision or research and development as on the nearby STP, but rather essentially geared towards urban transformation. The identification of effective communicators to support sustainability in confronting this novel task is particularly important in such a case.

The survey was structured into four main sections. The first section collected information on the informal social network of those communicating on the regeneration of Area 2 in Porto Marghera and who could act as sustainability communicators. The data was collected via a name generator question (individuals were asked to name those they communicate with). The use of the data in constructing the communicator score in the informal network is discussed in section 3.1.3. Included in the first section were also questions (both open-ended and closed) on the sustainability visions of these stakeholders with regard to the regeneration of Area 2, which are discussed extensively in section 3.1.1. The second and third sections asked network and sustainability questions on two specific projects (the Expo Venice pavilion and the Venice Waterfront), but their results are not reported here. The fourth and final section collected information on the sustainability practices of the respondents' organizations and on their decision-making position, both used as proxies for the formal network structure (see section 3.1.2).

We used snowball sampling and the online survey invitations were sent via email to a number of 153 individuals, out of which 28 respondents provided complete responses on all three sets of questions relevant for the framework, for a response rate of 19%.

The logical sequence of constructing the framework, the aim of which is to arrive at the sustainability communicator score, includes an analytical part (in section 3.1) and a synthetic part (section 3.2). In section 3.1, the construction of the sustainability vision, formal network influence and informal network influence dimensions is presented as a stepwise process of integrating more specific components. The most elaborate methodological construction underpins the sustainability vision (section 3.1.1), followed by the informal network influence (section 3.1.3) and the formal network influence (section 3.1.2).

3.1 *Dimensions of the sustainability communicator score*

The aim of the proposed methodology is to help a user (assessor) to assign scores (Sc) and rank actors who are part of a brownfield regeneration network according to their sustainability communicator abilities, by integrating the sustainability vision, formal network influence and informal network influence scores. The ranking is obtained by placing actors in descending order according to their sustainability communicator score.

To calculate the score, a Multi-Criteria Decision Analysis methodology (MCDA) was developed. MCDA includes a wide variety of methods for the evaluation and ranking, or selection, of different alternatives that takes into account all aspects of a decision problem considered relevant by different actors or users (Giove et al., 2009; Linkov et al., 2007).

The proposed MCDA methodology applies a hierarchical evaluation structure in which the sustainability communicator score Sc is obtained by the aggregation of three main dimensions: sustainability vision, formal network influence and informal network influence. Each dimension is composed of different indicators which are normalized and integrated together toward a single score.

The input data utilized by the methodology are based on contextual information supplied by unique respondents in unique circumstances. Therefore, an inherent indeterminacy (Doak and Karadimitriou, 2007b) or vagueness of sustainability values and choices as well as of the mechanisms of communication is expected. To keep track of vagueness, each dimension is characterized not only by its score but also by a corresponding degree of reliability (called vagueness scores in Figure 2).

To deal with this vagueness in quantitative terms, the proposed MCDA methodology makes use of Fuzzy Logic (FL) and Fuzzy Inference Systems (FISs) (Zadeh, 2008, 2005, 1983). FL is based on the concept of fuzzy sets which are sets where elements can have a partial degree of membership between 0 (not member) and 1 (full member). FL is the theory based on FISs which consists of methodologies for the selection of a suitable output based on fuzzy input values.

In what follows, we describe the process of constructing each of the three dimensions from a number of indicators and how the indicators are, in turn, derived from the survey questions.

3.1.1 The sustainability vision dimension

3.1.1.1 The components of the sustainability vision

In agreement with the literature, we used the three-pillar model of social, economic and environmental sustainability to identify the pillars that underlie respondents' views[2] on the sustainable development to be achieved in the regeneration of a given area (Hou and Al-Tabbaa, 2014; Tang and Nathanail, 2012). Apart from this deductive approach, we also used respondents' site-specific understanding of sustainability, which allowed researchers to inductively derive endorsement for the three pillars but also for pillar coalitions (combinations of pillars). The sustainability dimension is thus identified in terms of seven categories: the economic Ec, the social So and the environmental En, the social-economic *So-Ec*, the social-environmental *So-En*, the economic-environmental *Ec-En*, and the social-economic-environmental *So-Ec-En*.

We used three indicators to determine the pillar or pillar coalitions underpinning the regeneration goals identified by each respondent. The first indicator (#1 in Figure 2) captures the pillar (coalition) corresponding to the most important regeneration goal that the respondent freely formulates when asked about the sustainable regeneration of Area 2. The second and third indicators (#2 and #3) describe the pillar (coalitions) for the second and third most important goals, respectively. To arrive at these indicators, we used two questions: an open-ended question (discussed below) and a ranking question (applied in section 3.1.1.2).

The open-ended question[3] asked respondents to state in their own words the three sustainable development goals to be considered in the regeneration of Area 2. Compared to closed questions, open-ended ones offer advantages such as better thought out answers that are of higher quality (Callegaro et al., 2015). The respondent does not passively pick pre-defined responses from a list, which might not fit precisely with his or her views (Reja et al., 2003). In research on sustainability assessments at the local level, the ability of respondents to provide their own definitions and understandings is linked to a higher validity of results (Bleicher and Gross, 2010).

A total of 84 responses (28 respondents x 3 responses each) were analysed. Out of these, 81 could be assigned to one of the pillars or pillar coalitions based on the following *additive criterion*: if a regeneration goal is strictly related to one pillar, it is classified as belonging to that pillar. If the respondent hints at more than one pillar, his or her response is classified as a pillar coalition (several examples are given in Table 1). The coding was performed independently by two experienced researchers using the seven categories and their knowledge of the case. The inter-rater agreement was calculated for each goal and each respondent and yielded a value of 0.82, which means that the raters were in agreement 82% of the time. In order to assign the remaining 18% responses to one of the categories, the researchers reached complete agreement by jointly choosing the more inclusive category from their independent ratings.

We contend that the seven categories offer a broader range than that provided by the three pillars considered in isolation (cf. Pope et al., 2004). At the same time, the seven

[2] The survey also included a set of 18 specific indicators (six for each of the three pillars of sustainability), which are not reported in this analysis.

[3] This question was preceded by another one that ensured the validity of measuring sustainability opinions at the individual and site level. We asked respondents if they agree or not that the regeneration of Area 2 should conform to the goals of sustainable development

categories allowed the classification of almost 97% of the responses given by our respondents, thus offering a parsimonious approach to handling the diversity of responses.

Pillar category	Excerpts from the open-ended responses
Social	Social inclusion; social equity
Economic	Economic sustainability; economic revitalization of access from the mainland to Venice
Environmental	Environmental requalification; relationship between land and water
Social-economic	Supporting employment and attracting investment; Economy of knowledge
Social-environmental	Sustainable mobility (cycling and public transport); embellishment of the area
Economic-environmental	Using renewable resources, especially energy; promoting the sustainable use of materials.
Social-economic-environmental	Reconnecting landscape and environment on the way linking Venice and the mainland; urban regeneration.

Table 1. Illustration of coding of open-ended responses based on seven sustainability categories.

In applying the proposed methodology, we rely on a balanced view of sustainability and thus make the value-based assumption that the ideal situation is when all three pillars are mentioned by a regeneration actor. Mentioning two pillars is a less favourable view of sustainability, while a single pillar is the least favourable understanding of sustainability. Moreover, each pillar and each coalition of pillars can be assigned a different importance according to the preference of the users. In agreement with the literature (Littig and Griessler, 2005), our preference is for the triple pillar coalition to be the highest, followed by the social-environmental, social-economic, and economic-environmental. The single pillars are also assigned different but lower importance. To draw attention to the flexibility of the framework, we assign higher importance to the social pillar, the one most often neglected in policy making (cf. Boström, 2012), followed by the environmental and the economic pillars. These choices are illustrative and can be changed based on the theoretical criteria of the user.

Both the aforementioned conditions can be formalized by the use of a Normalized Fuzzy Measure μ which is user-defined and associates a preference score to each possible coalition of pillars (i.e. the power set generated from the set of pillars). The proposed Normalized Fuzzy Measure is represented with default scores in Table 2.

Pillars	Score
$\emptyset$	0.00
$\boldsymbol{Ec}$	0.12
$\boldsymbol{En}$	0.23
$\boldsymbol{So}$	0.30
$\boldsymbol{Ec, En}$	0.60
$\boldsymbol{Ec, So}$	0.70
$\boldsymbol{So, En}$	0.90
$\boldsymbol{Ec, So, En}$	1.00

Table 2. User-defined normalized fuzzy measure μ of pillars' coalitions importance

3.1.1.2 Integrating the components of the sustainability vision

The sustainability dimension captures the commitment towards sustainability of each actor involved in regeneration. It is calculated by taking into account the number of sustainability

pillars mentioned by each actor in response to the ranking question (sustainability goal #1, #2 and #3) ordered by decreasing importance. Among these answers, each sustainability pillar may be mentioned alone or in coalition with others at different levels of importance (from first to third). A descending score s_1, s_2, s_3 is associated to each of the three answers so that the sum of the scores is 1 and each score is one third larger than its successor; that is $s_1 = 0.50, s_2 = 0.33, s_3 = 0.17$. To evaluate the score associated to a single pillar or pillar coalition p among the three answers, scores of each answer where the pillar is mentioned are summed up. More formally the score $S(p)$ of pillar p is obtained by:

$$S(p) = \sum_{a|p \in a} s_a \qquad \text{Eq. 1}$$

Where $a|p \in a$ represents all answers where p is mentioned.

By integrating pillars' scores associated to mentions with the pillars' importance (as defined in 3.1.1 The *sustainability* vision dimension

3.1.1.1 The components of the sustainability Table 2) it is possible to evaluate the overall vision of sustainability of the social actor, weighted by the user's ordered preferences. This integration is performed via the Choquet integral $C_\mu(X)$ (Choquet, 1954), which allows to take into consideration that scores associated to a coalition of pillars are higher than scores for single pillars (see Table 2). The sustainability dimension score St is then obtained by:

$$St = C_\mu\big(S(Ec), S(So), S(En)\big) \qquad \text{Eq. 2}$$

The sustainability dimension helps identify the actors whose vision of sustainability comes closest either to a three pillar view or, if only two pillars are mentioned, to a choice that privileges the less common combinations of pillars (such as the social – environmental or the social – economic). In addition, the score is higher for those actors who rank such choices as their more important goals in the regeneration of the area under discussion.

3.1.1.3 The vagueness of the sustainability vision

The sustainability dimension is also characterized by a vagueness parameter, the role of which is to quantify the reliability of actors' answers related to the sustainability pillars. This quantity is not integrated into the dimension's score because it is utilized in the subsequent aggregation step towards an uncertain final result (see section 3.2).

Vagueness is calculated by comparing users' answers provided in five instances. The first three are the ordered indicators in the sustainability dimension (see section 3.1.1.1). In each of them, the respondent has a chance to state his or her sustainability vision, out of the seven categories. But is this preference stable across goals? We measure to what degree any given respondent endorses the same category across the three indicators and in response to two additional questions from the survey. The first of these additional questions is placed immediately after the open-ended and ranking questions and explicitly asks respondents about their preference for a sustainability category, with responses from "not at all" to "very relevant". In this analysis, only the "very relevant" option was considered. The second question is placed at the end of the survey, to avoid perceived redundancy, and probes once again into the pillar preference of the respondent[4].

[4] The last question made no explicit reference to the sustainability of regeneration on Area 2.

In sum, respondents have five opportunities to state their preference for a specific pillar or coalition. For each possible coalition of pillars (i.e. the Power set generated from the set of pillars, as reported in Table 2) the number of times it is mentioned in the subsequent answers is counted. The maximum between those counts is then used to assess firmness of choices, and from that calculate it's inverse, the so-called vagueness. A perfectly coherent setting will get a firmness score of 5 while the worst case will be 1. More formally if $C(c)$ is a function that counts sustainability category c's appearances, then vagueness Vt, which is supposed to be in the [0, 1] range, can be calculated as:

$$Vt = 1 - \frac{\max_{c \in \mathcal{P}(P)} C(c) - 1}{5 - 1} \quad \text{Eq. 3}$$

Where $c \in \mathcal{P}(P)$ means all the coalitions c which are part of the Power set of P where P is the set of all pillars.

3.1.2 *Formal network influence dimension*

So far we have described measures for stakeholders' views on sustainability as individuals. Since their status as stakeholders is linked to their membership in specific public or private bodies, we used two indicators to tap into the organizational sustainability practice and the formal role of stakeholders in regeneration.

Hou and Tabbaa (2014) have shown that the sustainability movement in brownfield management creates pressures for organizational change via institutional isomorphism. This is a process that "forces one unit in a population to resemble other units that face the same set of environmental conditions" (DiMaggio and Powell, 1983, p. 149). We use four questions from the online survey for collecting data on these institutional pressures. These are: (1) whether the respondent's organization carried out sustainability assessments of the projects in which it was involved; (2) whether it participated in sustainability assessments organized by others; (3) whether it requires sustainability actions of their contractors and (4) whether it was required to implement sustainability actions to comply with tender documents. These four dummy indicators (*yes/no*) are integrated into one indicator of "organizational sustainability practice". Full sustainability practice is associated with having all *yes* answers as opposed to no practice, which is given by all *no* answers. Giving a score of 0.25 to each *yes* and 0.025 to each *no* answer, the final sustainability practice score is obtained by summing up the single scores obtaining a score in the [0.1,1] range. This range starts from 0.1 in order to keep some kind of minimal sustainability practice even in cases where no answer has a clear statement related to sustainability. We assume that a minimal level of sustainability practice should be present in most organizations dealing with brownfield regeneration.

Besides the level of sustainability practice, we also consider in the calculation of the formal network influence score the formal decision making position of each actor within the regeneration project. From the literature on project ecology (Grabher, 2002), we borrow and adapt the distinction between a core team of decision-makers, a broader organizational layer known as the epistemic community and a broader social layer (Henneberry and Parris, 2013). The core team is in charge of making project decisions and so is best positioned to communicate sustainability expectations or requirements to their stakeholders. The epistemic community consists of consultants who can provide input into project tasks, either formally or informally.

Consistent with our assumptions, Hou and Tabbaa (2014) concluded based on an international survey study that the stakeholders with the strongest influence on the adaption of sustainable remediation practices are site owners and managers, primary consultants and top management. The third category of project stakeholders have a more diffuse role but can nevertheless support learning processes (Henneberry and Parris, 2013). Based on these

considerations, a descending score is associated to those categories so that the decision maker has a score of 1, the consultant a score of 0.66 and other stakeholders a score of 0.33. Each score is thus reduced by one third in comparison to the previous.

We designate the organizational sustainability practice score by So and the formal role in regeneration score by Sd. In order to calculate the formal network influence total score Sf, the two measures are integrated by multiplying their scores so that, in the best case, the score is 1 while in the worst case it is 0.033.

$$Sf = Sd \cdot So \qquad \textit{Eq. 4}$$

No vagueness score is envisaged in this dimension as both the formal position and the sustainability practice are considered as objective parameters not coming from a subjectively vague interpretation by the social actor.

3.1.3 *The informal network influence dimension*

The informal network influence score is related to the structural characteristics of the position of the assessed actor within an informal social network. By focusing on the individual level, this dimension captures the ways in which an individual can exert influence within the social network where he or she is located. We assume that this capacity to influence is related to the individual's centrality (Friedkin, 1991). Consequently, we use four social network centrality metrics: degree centrality, betweenness centrality, eigenvector centrality and closeness centrality, which are explained below.

Freeman played a pioneering role in unpacking the notion of centrality beyond the empirical intuition that a person (A) located at the centre of a star is in a special position in relation to the overall structure (see Figure 3) (Freeman, 1978). The central actor (node A) is central in three distinct ways. He has the highest number (*degree*) of ties to the other actors, he lies *between* the other actors and he is *closest* to all the other actors (Prell, 2012). This means that actor A in Figure 3 has the highest degree centrality, betweenness centrality and closeness centrality, respectively. Eigenvector centrality cannot be directly illustrated in Figure 3, as it based on the centralities of the actors to whom a given actor is related, all of which are 1 in this case.

Figure 3. [Approximately here] *Star graph as visual interpretation of centrality measures*

Source: Freeman (1978), Prell (2012).

Degree centrality is the number of direct (or immediate) ties that an ego has to its alters. It is a measure of activity and direct influence of an actor on surrounding actors (Scott, 2014; Wasserman and Faust, 1994). An actor displaying high degree centrality is a major channel for communication among those he is in immediate contact with (Prell, 2012).

Betweenness centrality is a more refined measure of centrality as it takes into account not only the immediate neighbours of each node, but also the rest of the network. The meaning of this measure is that if an actor is "placed between two disconnected actors, then this placement of betweenness affords certain advantages" (Prell, 2012, p. 104). For example, if actor A would be removed from the network in Figure 3, the network would be replaced by a set of isolated individuals. In a communication network, betweenness centrality indicates how much an actor can exercise control over the flow of information (Marsden, 1990; Prell, 2012). In Figure 3, actors D and C cannot directly communicate unless this is made possible by the actor positioned between them, namely A.

Closeness centrality is also a network-wide metric of centrality. Actors with high closeness centrality are those who have the shortest distance to all the other actors. Because

they tend to rely on few intermediaries, they can quickly diffuse information through the network (Prell, 2012). Researchers have considered closeness centrality as a measure of how influential the opinions of an actor can be throughout a network. The influence of actors with high closeness centrality spreads faster than that of more peripheral actors (Friedkin, 1991).

Finally, eigenvector centrality is the sum of an actor's connections to others, weighted by the degree centrality of these other actors (Prell, 2012). This means that an actor does not necessarily need to have many direct ties in order to have access to a great many other actors. If the actor is connected to a few actors who are, in turn, well connected to others (high degree centrality), he can still be influential in spreading his opinions.

In sum, the four measures of centrality can be used to assess, in different ways, how effective the communication of sustainability can be achieved by different actors, given their structural position in a communication network. It needs to be emphasized once again that we deal with the individual actor level and thus can only make statements on their role as communicators within a network configuration. We do not focus on the strength of ties (strong or weak) and cannot draw any conclusions on the outcomes of communication.

The informal network influence score Si is calculated starting from the four network metrics (degree, betweenness, closeness and eigenvector centralities) calculated with the NodeXL software. The normalized values[5] of these metrics are aggregated by using a weighted average. Weights are initially set to be all equal but the user may change them according to his/her preferences. Given the set of network metrics $M = \{m_1, \dots, m_4\}$ and their corresponding weights $W_m = \{w_{m1}, \dots, w_{m4}\}$ the informal network influence score Si can be calculated as:

$$Si = \frac{\sum_{i=1}^{4} m_i \cdot w_{mi}}{\sum_{i=1}^{4} w_{mi}} \qquad \textit{Eq. 5}$$

The informal network influence score is based on the idea that the higher number of other actors an actor is able to reach, the better he can communicate about sustainability.

There is some uncertainty as to how the message of an actor is distorted while reported by his immediate contacts to actors located two or more steps further away from him. In order to take the latter uncertainty into account, a vagueness score for the informal network influence Vi is calculated. We assume that direct communication is the most precise, followed by communication to neighbours (who themselves communicate to others) and ending with diffuse communication from one actor throughout the network. We therefore assign the highest precision to degree centrality c_d followed by eigenvector centrality c_e and closeness centrality c_c. Betweenness centrality is not taken into account for vagueness as it is not related to message distortion as defined above. Vi is calculated by the inverse of the weighted sum of the three reliability related network metrics where the sum of the weights is 1 and each weight is one third bigger than its successor, that is $w_d = 0.50,\ w_e = 0.33, w_c = 0.17$:

$$Vi = 1 - (c_d \cdot w_d + c_e \cdot w_e + c_c \cdot w_c) \qquad \textit{Eq. 6}$$

3.2 *Integration of the dimensions and calculation of the sustainability communicator score*

The final step to obtain the sustainability communicator score for an actor in the regeneration network consists in aggregating the results coming from the three dimensions described. As already stated, results for the three dimensions cannot be regarded as precise and certain but

[5] The normalization was done based on the highest network metric empirically observable in the network (relative normalization).

rather as vague. In order to better communicate this vagueness, the scores obtained are classified into three classes of importance: low (L), medium (M) and high (H).

The three classes are generated by equally subdividing the domain space, from 0 to 1, in three sections. To this aim, two sectioning thresholds are established: 0.333 is the low to medium threshold t_1 while 0.666 is the medium to high threshold t_2. This classification step is part of the standard FISs (Gottardo et al., 2011; Murofushi et al., 1994; Turksen, 1992; Zabeo et al., 2011) methodology which consists in first fuzzifying values, then applying fuzzy inference rules (i.e. if-then logic rules) and finally defuzzify results.

Fuzzification is obtained by using the vagueness score[6] associated to each dimension's score as provided for in FL's methods (Zadeh, 2008, 1965). By following the FL rationale, each dimension can have a different degree of membership for each of the three classes according to its value and vagueness. A maximum vagueness amount is established to be half the range of a class, i.e. 0.1666, and a triangular membership degree shape is created around the score value so that when the vagueness score is zero the triangle becomes a single spike while when the vagueness score is one, the triangle has a base 0.1666 wide centred on its score as depicted in Figure 4. The area of the obtained triangle overlapping with one or two adjacent classes is then used to measure the membership degree of the dimension of concern for those classes.

Figure 4. [Approximately here] *Fuzzy classification triangular membership degree area*

Once scores for each dimension have been fuzziefied (i.e. each dimension is associated with one or two classes with related degree(s) of membership) fuzzy inference rules (FIRs) are applied. FIRs are conditional if-then propositions, consisting of the three dimensions (sustainability vision *St*, informal network influence *Si*, and formal network influence *Sf*) as antecedents and a score as consequent. Each antecedent may belong to one of the three classes (Low, Medium and High), with a degree of truth between zero and one, and the consequent may also have a degree of truth between zero and one.

Figure 5. [Approximately here] *Fuzzy inference rules and scores*

The proposed FIRs are generated by the logical conjunctions of each possible permutation of classes for the three dimensions as antecedents with an associated consequent, which is a score assigned by the user in the [0,1] domain. Default proposed scores and their justification are reported in Figure 5. These represent all the possible definitions of FIRs, as established by the researchers, which may or may not apply for any single actor.

To evaluate the described FIRs, the Takagi–Sugeno–Kang (TSK) Fuzzy Model (Gottardo et al., 2011; Sugeno and Kang, 1988; Takagi and Sugeno, 1985) is applied. Following the TSK rationale, as antecedent's elements are connected through the conjunction operator, the degree of truth for the whole antecedent is established by applying the minimum T-norm operator (Klement et al., 2013) among the degrees of truth of its elements (i.e. the minimum of the membership degrees for the different classes among all dimensions).

The final FIS step is defuzzification, which is necessary in order to create an ordered ranking of actors as the goal of the proposed methodology. The TSK method applies defuzzification directly during the evaluation of the FIRs. In fact, as more than one proposition can have a degree of truth higher than zero, the final defuzzified score is obtained by the weighted average of consequents' scores weighted by their corresponding degree of

[6] Vagueness for formal network influence is set to 0

truth. If ρ is any possible permutation of classes for the three dimensions (i.e. an antecedent row in Figure 5), $m(\rho)$ is the membership degree function that gives the membership degree of permutation ρ and $\phi(\rho)$ is the scoring function that gives the score associated with permutation ρ, then the final sustainability communicator score S_c can be calculated as:

$$Sc = \frac{\sum_{\forall \rho} \phi(\rho) \cdot m(\rho)}{\sum_{\forall \rho} \phi(\rho)} \qquad \textit{Eq. 7}$$

Before turning to the results, a clarification is needed. As fuzzy logic is employed in different steps of constructing the methods, a summary of its usefulness is offered here. First, it allows the formalization of stakeholders' preferences for one or more of the three sustainability pillars as well as for their weighting by users' preferences (via the Choquet integral). Second, it allows the integration of the three sustainability communicator dimensions via user defined fuzzy inference rules. Third, fuzzy logic allows the use of a vagueness score for two of the three dimensions. In this way, it becomes possible to account for the real life complexity of people's visions of sustainability and also for their inherently uncertain roles in acting as informal communicators in the communication network.

4. Results and discussion

Applying the aforementioned methodology to the case study in Porto Marghera, we obtain the following two sets of results. First, we get a sustainability communicator score for each actor, that allows us to rank them from the highest to the lowest. Second, by using the visual representation capabilities of NodeXL, we create a network map of the relative positions of the sustainability communicators identified in our case study (see Figure 6). In what follows, we report on both sets of results and provide a *prima facie* validity assessment of the framework, at the aggregate level and for each of the three dimensions, namely sustainability vision, formal network and informal network influence. Given the interest in sustainability as communicative practice with which we started out, we conclude by showing that there is a noteworthy correlation between sustainability vision and sustainability communicator score.

At an aggregate level, the results confirm the expectations of the methodology as constructed above. First, it enables the identification and ranking of the top sustainability communicators in the network. The larger spheres in Figure 6 are the best sustainability communicators under the given assumptions. This means that we succeeded in identifying the actors who come as close as possible to endorsing the three-pillar view of sustainability and are, at the same time, in contact with a great many other actors.

The range of variation of the sustainability communicator score (Sc) is between 0.750 (the top communicator, actor A on the map) and 0.029 (actor B). By subdividing the ranked set of sustainability communicators in three equal classes (low, medium, and high[7]), we find that approximately 39% (11) of all actors are in the low sustainability communicator class, 57% (16) in the medium and 4% (one actor) in the top class.

Figure 6. [The updated figure 6 (5Aug2016) to be placed approximately here] *Network map of sustainability communicators (Area 2).*
Note: Both spheres and circles represent individual actors, whether included in the survey (spheres) or not (circles). The size of the spheres is proportional to their sustainability communicator scores. Their darkness is related to their sustainability vision score: the higher the score, the darker the sphere. The lines are communication ties between actors.

[7] The low class includes scores => 0 and <= 0.333, the medium class scores >0.333 and <=0.666 and the high class scores >0.666 and <=1.000

The aggregate results can be used by stakeholders interested in promoting sustainability by means of social persuasion. For example, a hypothetical sustainability promoter such as a site owner, manager, consultant or regulator (cf. Hou and Al-Tabbaa, 2014) interested in promoting a vision of sustainability well balanced across all three pillars might start by contacting actor A, who is discursively closest to this vision. Given A's location in the network, he is best positioned to reach out to other actors and persuade them to adopt the same perspective. However, he cannot single-handedly reach all the other actors. The *Sc* score ranking and network map show that A is not alone. The 16 sustainability communicators with medium values on the *Sc* score are the next that the hypothetical sustainability promoter can turn to in order to spread the word on the balanced vision of sustainability.

Who these 16 are and especially where they are located illustrates the usefulness of having a network-based ranking of sustainability communicators. There are three relatively distinct areas where these sustainability communicators are positioned. One area (top right part of Figure 6) includes the communicators in the proximity of actor A. Given the high density of such communicators in this area, the effectiveness of persuasion is expected to be highest so that the sustainability vision being promoted may take hold fastest here.

The other two areas (left and bottom right dashed shapes in Figure 6) are characterized by lower densities of sustainability communicators. Given the peripheral position of these areas, in comparison to the central area above, the potential role of the communicators found here may nevertheless prove crucial for the hypothetical sustainability promoter. The reason is that these communicators are uniquely positioned to act as bridges connecting stakeholders potentially isolated from the balanced sustainability discourse. After discussing the overall *Sc* scores and their usefulness, attention now turns to each of three dimensions.

At the dimension level, the sustainability vision score (*St*) varies between 0.3 (the lowest value) and 0.87 (the highest). The respondents with the lowest scores consistently define their sustainability goals in terms of only one of the three sustainability pillars. Moreover, their choice tends to be closely related to the economic or environmental pillars. For example, the respondent with a 0.3 score on this dimension, mentioned as the three (ranked) goals that he considered worth pursuing in the regeneration of Area 2: the development of "accommodation and port-related tourist services", the achievement of "an exhibition and congress space" and the development of an "access gate to Venice". All three are related to the expansion of the economic base of the Venetian tourist industry and do not refer to the social or environmental aspects of sustainability. The contribution of this actor to sustainability promotion is correspondingly low. Future research might consider developing a threshold for separating stakeholders with low sustainability scores so that they are not simply considered sustainability promoters of low effectiveness but rather a special category of "stakeholders to be persuaded" in order to increase their sustainability vision scores.

In contrast, the respondent with the highest score (0.87) endorsed goals that were more clearly multi-pillar, such as the "revitalization of the territory", the "green economy" and "urban regeneration" for the first, second and third goals respectively. The references to "revitalization/regeneration" and "green" suggest the environmental component, while the reference to "territorial" or "urban" aspects points to the social aspects of sustainability. This actor comes closest to the balanced vision of the hypothetical sustainability promoter mentioned above.

The vagueness of sustainability choices *Vt* varies between 0 and 1, but these need to be read as inverse values: the actor with a vagueness of 0 is the firmest in his choices. In our case, this actor consistently chose the economic pillar across all five sustainability questions. In contrast, the score of 1 was assigned to the respondent who endorsed dissimilar sustainability categories for the three ranked regeneration goals: economic, economic-

environmental and social-economic, respectively, and for the overall sustainability preference (social-economic-environmental)[8]. For the sustainability promoter, it is important that a low value of vagueness should be seen as favourable for a balanced view of sustainability only if it endorses a three-pillar vision. A steadfast adherence (low vagueness) to only one pillar undermines the sustainability vision as understood here.

The scores for the formal network influence (*Sf*) dimension vary between 0.03 and 1. The lowest value is for an actor who has neither a decision-making position nor a consultant position and whose organization (a trade union) does not report any sustainability practices. The score of 1 was obtained by a decision-maker (developer of Area 2) who also reports that his organization carries out all sustainability activities queried on in the survey. The latter is best positioned to promote sustainability as a formal requirement, although the effectiveness of the latter is expected to be greatly enhanced if it is doubled by informal influence.

The informal network influence dimension score (*Si*) varies between 0.12 and 1. The lowest score (actor C in Figure 6) describes an actor who is at the periphery of the network and who is in direct contact with a single actor. Yet, despite this low influence position within the network, the fact that this actor endorses a two-pillar vision of sustainability, places him above the minimum in terms of sustainability communicator score (position 23rd of 28).

As expected, the actor with the highest informal network influence scores highest on all centrality measures (degree, betweenness, eigenvector and closeness) (actor D in Figure 6). The final sustainability communicator score places him, however, in the 8th position, despite his extensive connections, because he endorses a narrow view of sustainability. In considering the scores of actors C and D, the hypothetical sustainability promoter might be faced with a more general dilemma: which is easier to change, one's sustainability vision (as in the case of actor D) or the number of their connections (for actor C)? If the former can be changed, the payoff can be "winning over" the best connected network member. However, if the latter's vision proves resistant to change, the sustainability promoter might need to work with less well connected persuaders but who are closer – discursively – to the vision being promoted.

Finally, the communicator vagueness score (Vi) varies between 0 and 0.9. As with the vagueness measure for sustainability vision, the top communicator receives the score of 0 and the least efficient the score of 0.9. For each of them, the score describes the communication structure surrounding the actor. The least efficient communicator C has a normalized degree centrality of 0.06, while his normalized closeness centrality is 0.41, which means that his diffuse influence in the network overshadows his direct influence as sustainability communicator. However, for the sustainability promoter interested in fast and measurable change towards balanced sustainability, it is the direct influence that is of prime interest.

As stated above, a full validity assessment of the framework is beyond the scope of the paper. However, the correlation between sustainability vision and sustainability communicator score lends additional credence to its validity. In Figure 6, it appears that the largest spheres also tend to be ones with darker colours. This is confirmed by the scatterplot in Figure 7. The actors with higher sustainability communicator scores tend, in general, to have a higher sustainability vision score. The two scores vary in the expected direction.

Figure 7. [Approximately here] *Scatterplot of sustainability communicator score and sustainability vision score (Area 2). Note: the sizes of the spheres indicate the number of individuals in identical positions on the two axes.*

[8] The last question from the survey on sustainability pillar propensity received no response from this participant.

However, the relationship is not trivial. Within each class on the *Sc* score, there is a range of variation in the sustainability vision score. The hypothetical sustainability promoter may find the plot useful for choosing only those sustainability communicators whose visions are reasonably close to the three pillar view of sustainability. He or she may choose, for example, from the 16 stakeholder with medium *Sc* scores only the 12 who also score medium on the sustainability vision dimension (there are none scoring high on the latter).

5. Conclusions

The article has started out by advocating a less common perspective on sustainability that draws on the notion of communicative practice. If sustainability is conceptualized as *a content which is communicated among actors* with the aim of persuading them to adopt a specific vision of sustainability, the concept becomes methodologically more manageable and constructive than the dichotomy between discourse and practice. The notion of social network and the scholarly field of SNA provide the tools to explore how sustainability is communicated among actors involved in patterned relationships.

The proposed approach enables researchers and practitioners of sustainable regeneration projects to address two interrelated questions: (1) *who* are the most effective communicators in matters of sustainability in a given urban setting? And (2) *where* are they positioned? Rather than a simple ranking based on individual attributes, our SNA-Fuzzy logic approach provides an integration of individual and network attributes as advocated recently by Ramirez-Sanchez (2011). Moreover, this integration is highly flexible as it allows the user to set weights according to their own sustainability preferences and particular network configurations.

In this article, an integrated and interdisciplinary methodology was developed for analysing how the definitions of sustainability goals for a given urban context and project – a discursive form - can be communicated among actors located in definite positions towards each other. The social network patterns are conceptualized both in formal and in informal terms. The formal aspect is related to the decision-making roles of actors involved in regeneration, consistent with recent research on brownfield remediation (Hou and Al-Tabbaa, 2014). The informal aspect of networks is the more innovative one, as it draws on a long tradition of social science research (Borgatti et al., 2009) but applies it in an emerging area of scholarly exploration, namely sustainable brownfield and urban regeneration.

The proposed research design shows how qualitative and quantitative social science data can be integrated with social network data by means of a rigorous mathematical methodology. Over the successive steps described in section 3, researchers arrive at a unique score that summarizes the information (but also the degree of vagueness) contained in the sustainability, formal network and informal network dimensions.

Future research on sustainable regeneration, using this design, could be developed along two paths: an applied and a theoretical one. For the applied path, the most promising seems to be the further exploration of the validity of the framework, by testing hypotheses on the correlation between the three dimensions and the final score, under empirically specified assumptions. For example, comparative studies of regeneration contexts in which the goal of sustainability is pursued with stringency, could reveal if formal or informal channels play the leading role. Alternatively, comparing more or less progressive urban regeneration policies could shed light on the role of stakeholders' visions and their actual propensity to communicate such visions to others in promoting sustainability.

The theoretical path is to move beyond the actor level –the focus of this article - in order to engage with configurations of actors and with network-wide processes of communication. The final aim is to explain changes in sustainability starting from changes in discourse, via changes in interpersonal communication and taking concrete shape through changes in actual regeneration practices. The links and their direction can be much more

complicated but, the essential point is that stakeholders will always use communication as a prelude to their joint action, especially when faced with novel and complex tasks in promoting sustainability. The ranking exercise presented here could be applied to identify the most promising network configurations in which sustainability strategies or ideas are discussed, negotiated and planned.

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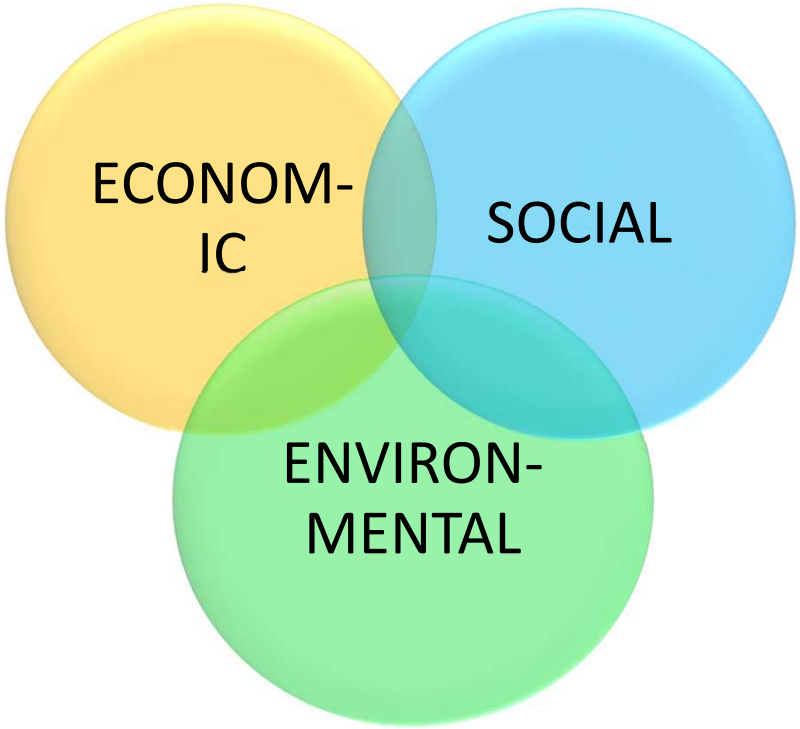
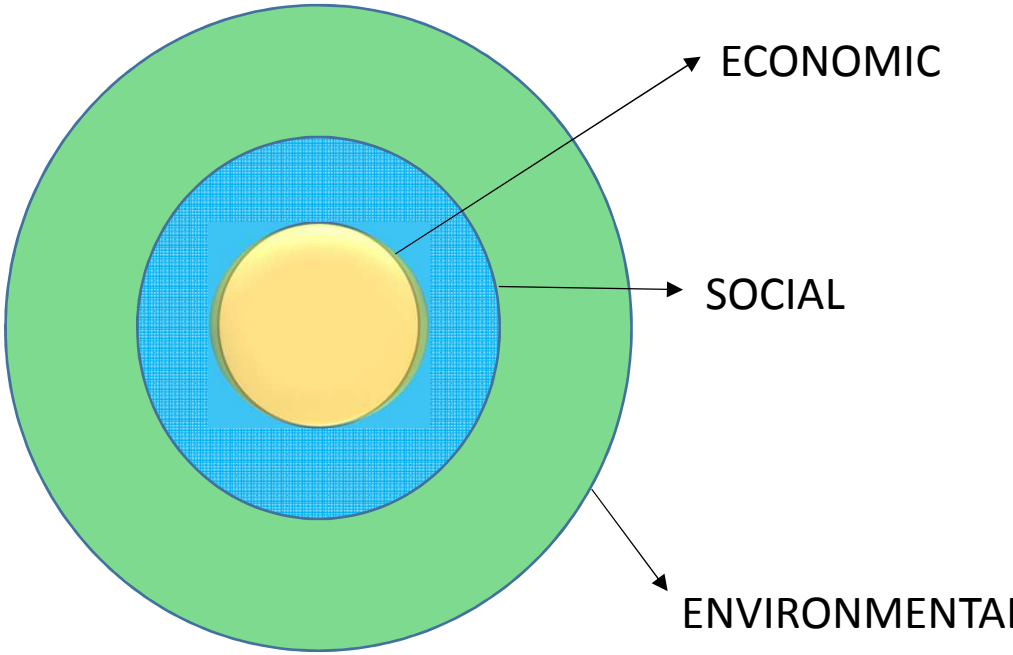
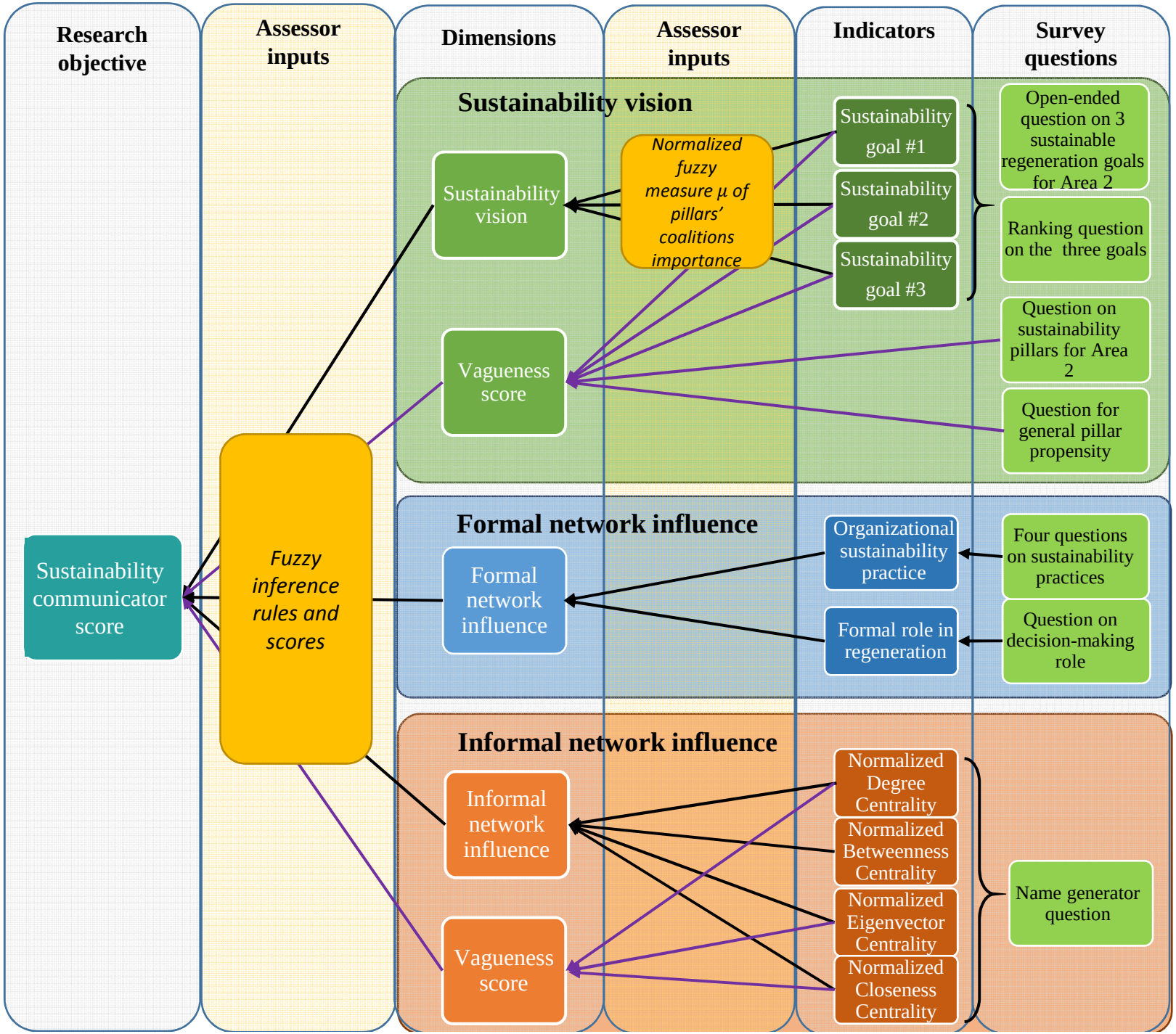
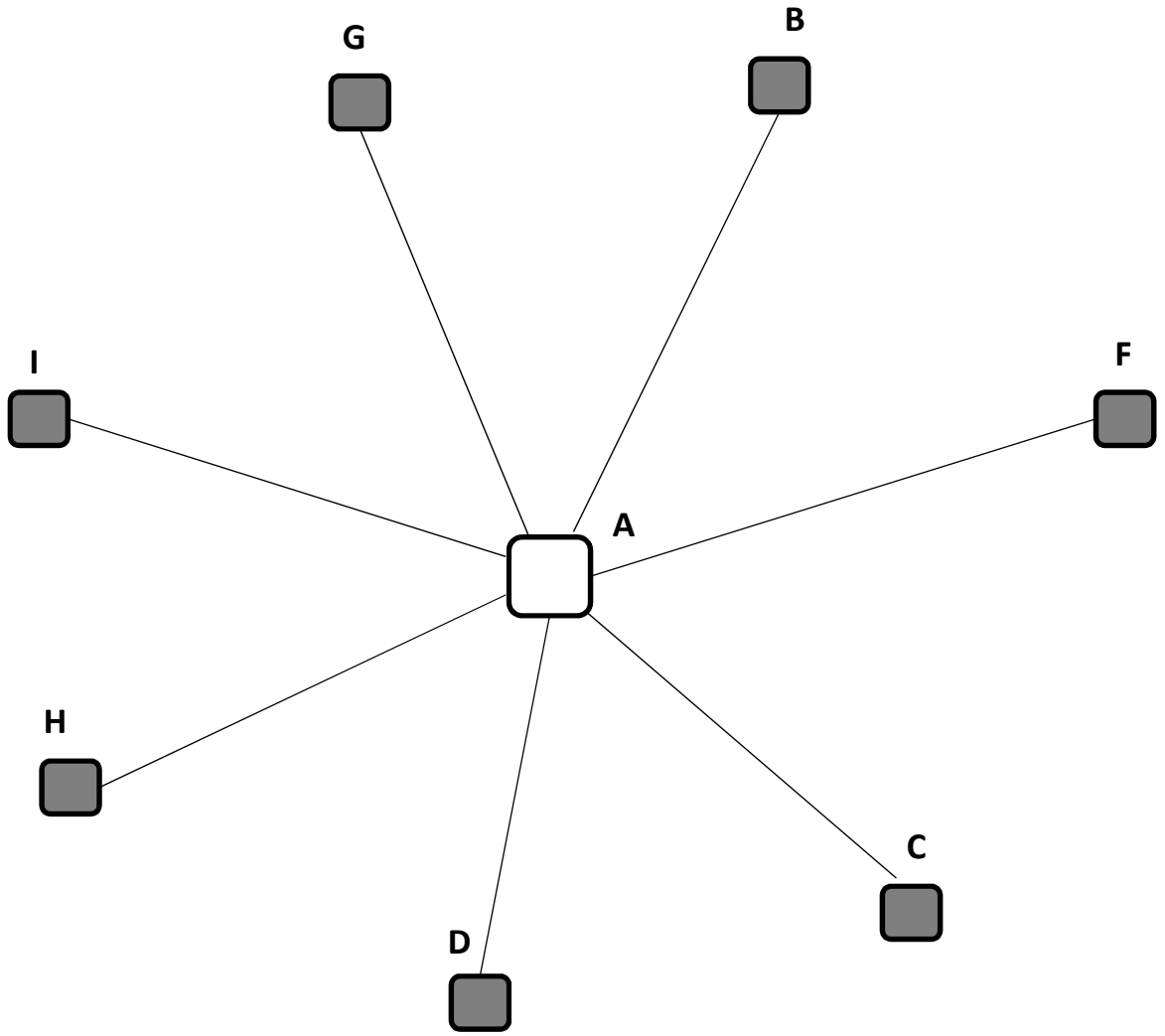
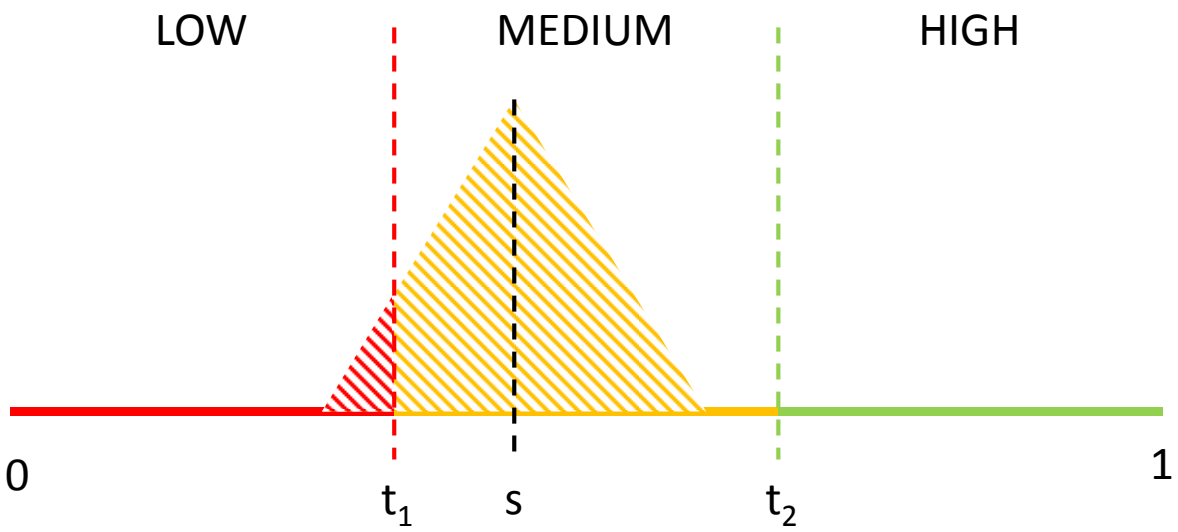










Antecedents			Consequent
St	Si	Sf	Score
L	L	L	0.000
L	M	L	0.000
L	H	L	0.000
M	L	L	*0.125*
M	M	L	*0.250*
M	H	L	*0.375*
H	L	L	***0.250***
H	M	L	***0.500***
H	H	L	*0.625*
L	L	M	0.250
L	M	M	0.250
L	H	M	0.250
M	L	M	*0.375*
M	M	M	*0.500*
M	H	M	*0.625*
H	L	M	***0.500***
H	M	M	***0.750***
H	H	M	*0.875*
L	L	H	0.375
L	M	H	0.375
L	H	H	0.375
M	L	H	*0.500*
M	M	H	*0.625*
M	H	H	*0.750*
H	L	H	***0.625***
H	M	H	***0.875***
H	H	H	*1.000*

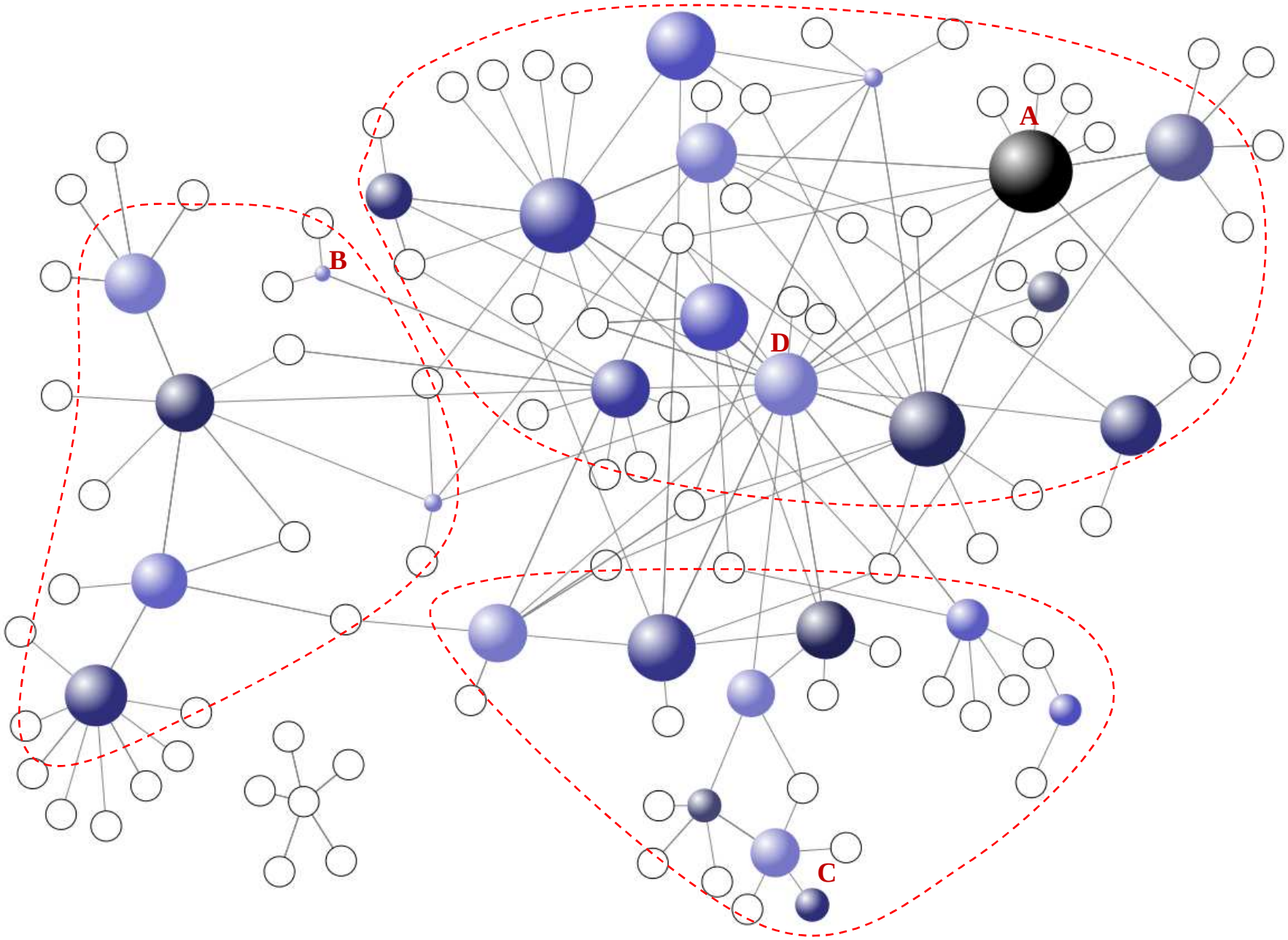
Formal network influence (Sf) is at the lowest level. Informal network influence (Si) is variable but it is irrelevant because the actor has a low score on the sustainability dimensions (St), so the score stays unchanged.

Once the actor has a medium antecedent on the sustainability dimension (St), the informal network influence plays an important role (hence the gradual progression of 0.250, highlighted with italic), even if the formal network influence (Sf) is still low.

We assume that the combination of a high sustainability antecedent (St) and at least a medium informal network influence (Si) produces a kick-off effect, hence the significant increase in the final score (0.250) between low and medium Si, highlighted in italic-bold.

The same rules applied as above, starting from a medium level (0.250) of formal network influence.

Same rules applied as above, starting from a high level (0.375) of formal network influence. The highest score is 1.000.


A
B
C
D