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Sustainability assessment: an integrated approach with inhabitant participation

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Abstract

Our research has led us to develop a method for formulating sustainability strategies for neighborhood rehabilitation. This method is targeted to decision-makers in charge of implementing projects for the regeneration of the built environment at various levels within the urban and building scales.
The methods and tools suggested here, which have been tested in collaboration with Comune di Bologna –the Bologna City Council- and ACER Bologna –the local Agency for public housing- make use of both technical/objective parameters and a participative approach to address the environmental and social sustainability requirements of citizens, local policies, and EU indications.

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1. Towards a sustainable urban development

Improving housing standards and quality of life, and regenerating urban immovable assets: these have the potential for being the most dynamic markets within the European construction industry in the near future. However, a number of complexities were encountered as a result of a three-fold goal structure: the demand for comfortable, high-performance urban buildings and spaces had to be reconciled with both the necessity of addressing environmental issues and the need to implement inclusive, participative processes that would ensure the integration of sustainability into rehabilitation projects.

The emergence of these trends has been catalyzed by new policies at the regional, national, and

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European levels [1] [2] and by the public's growing sensitivity to sustainability issues. The construction processes of the near future will have no choice but to address these trends and to undergo modifications in order to comply with emerging methods and models.

The ECTP's "Vision 2030" highlights the following principal objective for the near future: "to form alliances, particularly between the product end-users and the main actors in the construction process, to create a robust platform for development and realization of Cities of Europe that meet the needs and wishes of their citizens"[3]. The short term goal is thus to plan and implement projects that: guarantee satisfactory technical performance; meet the needs of end users; provide a transparent account of the decision-making process; and deliver results that can be assessed through efficient, shared indicators.

The complex array of actors involved in the construction process, continuously evolving norms, and the current condition of immovable assets have made it necessary to develop specific methods and tools that combine objective parameters and participative assessment techniques to evaluate the quality of projects. The research presented herein proposes one such set of methods and tools that is based on a common approach and is designed to be applicable at both the neighborhood and building scales.

2. Method and tools developed

This method postulates the following as initial conditions: within a given context, a group of actors within the construction industry (developers, designers, companies, property managers) decide to launch a project to regenerate the built environment in compliance with social and environmental sustainability principles. This is done by applying procedures that were developed in collaboration with the stakeholders and that were designed to define the project's priorities, ensure the quality of its processes, and provide a plan to assess its results.

The purpose of this method is to provide support during the decision-making process by providing a procedure that will accurately assess the sustainability of urban environments and identify crucial issues that must be addressed. This method can be applied to the status quo in order to identify initial conditions, and consequently, to prioritize the goals of a potential regeneration project. When applied to ongoing or completed projects, this method provides an assessment tool that can be used to evaluate and compare the outcomes of said transformations. The following is an illustration of the schemes that were developed for both the neighborhood and building scales and that were designed to complement each other.

2.1. System for the assessment of sustainability at the neighborhood scale

Assessment at the neighborhood scale investigates the environmental and social sustainability profiles of buildings, public spaces, and infrastructure within urban districts or areas, that are subject to rehabilitation or regeneration programs. The proposed method aims to implement a diagnostic process that is as objective and transparent as possible. Therefore, critical issues will be identified and prioritized for the purpose of developing a project plan that will include a hierarchical list of regeneration tasks to be carried out.

In order for an assessment to provide information that is sufficient to determine the salient characteristics of the urban areas under investigation, the procedure must include:

- a sustainability objectives framework
- a set of indicators and accompanying assessment criteria
- a calculation tool to be used to formulate the assessment

Given that the sustainability objectives list and set of indicators must be valid, mutually consistent, and produced from data empirically obtained in the field, they were derived from analogous objectives frameworks and sets of indicators used to estimate sustainability in a number of environmental

assessment methods [4] [5]. More specifically, the HQE2R [4] method was honed and adapted to suit this particular purpose. It was used to create a prioritized and structured list of general and specific sustainability objectives tailored to the neighborhood and urban district scales (Fig. 1).

SD Objectives	SD Target
To preserve and enhance heritage and conserve resources	1 - To reduce energy consumption and improve energy management 2 - To improve water resource management and quality 3 - To avoid land consumption and improve land management 4 - To improve the consumption of materials and their management 5 - To preserve and enhance the built and natural heritage
To improve the quality of the local environment	6 - To preserve and enhance the landscape and visual comfort 7 - To improve housing quality 8 - To improve cleanliness, hygiene and health 9 - To improve safety and risk management 10 - To improve air quality 11 - To reduce noise pollution 12 - To minimise waste
To ensure diversity	13 - To ensure the diversity of the population 14 - To ensure the diversity of functions and activities 15 - To ensure the diversity of housing supply
To improve integration	16 - To increase the levels of education and job qualification 17 - To improve access to the social and economic opportunities 18 - To improve the attractivity of the neighbourhood 19 - To improve the eco-mobility
To reinforce social life	20 - To reinforce local governance 21 - To improve social networks and social capital

Fig. 1. The sustainability objectives framework (Derived from : HQE2R project)

In order to facilitate the application of the assessment model, the sustainability objectives and accompanying indicators have been broken down into a number of specific analyzable domains, each corresponding to a professional specialization and potential area of intervention. These domains are:

- an intangible domain that encapsulates demographic, social, and quality-of-life factors (e.g. population social heterogeneousness, quality and accessibility of services, sustainable transport, etc.)
- the physical domain of buildings and their spaces
- the physical domain of open public spaces (green spaces and spaces that favor assembly and aggregation)
- the physical domain of transport networks serving buildings and open spaces
- the physical domain of technological infrastructure.

The set of indicators comprises a series of qualitative and quantitative parameters that are

differentiated according to processing and application method. However, depending on the availability of the necessary data for their formulation, they have all been designed to: optimize the objectivity of analyses; reduce the margin of interpretability of assessments; optimize applicability to the situation in the Emilia Romagna Region.

The indicators include:

- quantitative indicators distilled from objective, measurable data obtainable from public administrations, local statistics agencies, or the archives of the owners or managers of the immovable assets in question
- qualitative indicators distilled from information that was obtained through preliminary research, including data gathered in the field.

Depending on the nature of the phenomena observed within each of these two macro-categories, one of two distinct assessment methods can be employed: an analytical index can be calculated by applying an algorithm to measured data; or a carefully-formulated qualitative judgment can be submitted by technical consultants on the basis of certain explicit criteria.

Quantitative indicators that are less subject to interpretability either because their sustainability scale is based on established benchmarks or because it is known to be reliable (as for values obtained from statistics or norms) can be directly assessed using algorithms.

On the other hand, carefully-formulated qualitative assessments are used for indicators which cannot be traced back to a general assessment scale that is independent of specific contexts. This is true of most indicators pertinent to the socio-cultural sphere. It is also true of some indicators that require the simultaneous consideration of several technical parameters, and which must therefore be interpreted as a whole in a critical manner. The latter interpretation can be supported by results from participative surveys or by the expert opinions of specialists endowed with the necessary technical knowledge.

This set of indicators arranged according to priority constitutes the backbone of the assessment as a whole, for which procedures and application rules have been defined and for which certain support tools have been produced. The principal phases required to formulate an assessment are:

- acquiring existing data from government agencies and private entities
- obtaining any other necessary data in the field
- generating indicators and calculating their respective indices
- analytically assessing indicators and ascribing their rating as a function of the sustainability scale used
- overall assessment to determine general and specific objectives based on the common scale used.

Assessments can be made either by attributing equal importance to all the factors involved in determining the sustainability of the urban area under investigation (e.g. general and specific objectives, indicators) or by ascribing a different weight to each of these as a function of specific predetermined priorities within the local context. While the added flexibility of this operation can facilitate the application of methods within specific contexts, it also entails a greater risk of interpretability. Consequently, the criteria used to ascribe a certain weight to each factor must always be carefully studied on a case by case basis.

A specific set of tools has been developed to assist in every phase of the assessment process. The two-fold purpose of these tools is to optimize assessment objectivity and facilitate assessments:

- a check-list for the acquisition and measurement of various kinds of data is provided to help identify the information (data type, consistency, and possible sources) that will be necessary to generate indicators;
- indicator-specific instruction sheets illustrate and guide users through data processing and index calculations by specifying value conversion methods according to the common sustainability scale;
- a digital tool makes use of the common scale to generate complex assessments based on the simultaneous consideration of several parameters and provides a graphic visualization of results.

2.2. System for the assessment of sustainability at the neighborhood scale

Once the quantitative analytical indicators have been produced and used to generate their respective indices at the urban district scale, the system requires that they be integrated with information obtained from a participative diagnosis of sustainability. The goal of the latter is to investigate inhabitants' perceptions of the physical and environmental quality of the spaces they live in, the quality of services and facilities, and the degree of social integration.

One salient characteristic of the proposed assessment system is its use of a participative approach, which allows assessments to take into account the input of various subjects involved in the regeneration process, whether they have some vested interest in the latter, or whether they be end-users, citizens, or residents.

The participative diagnostic system can help obtain the data needed for the design phase of urban planning projects in a way that is complementary to the technical/objective assessment system, thanks in part to the adoption of the same system of prioritized sustainability objectives.

Therefore, although urban quality, for instance, can be measured using conventional urban planning standards that evaluate the quality of services and infrastructure, this measurement is only partially reliable. A more effective measurement can be obtained through user surveys and by involving users in participative processes and activities, including research and envisaging future scenarios. This is because the impact that services and infrastructure exert on quality of life is influenced especially by their efficiency, accessibility, use, and by a variety of intangible, collateral factors that significantly affect inhabitants' perception.

The configuration of the participative assessment system is characterized by phases, rules and tools that include:

- a questionnaire template,
- a set of protocols facilitating the execution of survey campaigns (including phases and rules)
- a calculation tool used to process and view results.

The principal assessment tool developed for this purpose is the "Neighborhood quality and sustainability" questionnaire template. It is structured in such a way as to enable a comparative reading with the results of the objective assessment. The questions, which are phrased to optimize clarity and comprehensibility, are designed to elicit simple, immediate answers from users.

2.3. Participative system for the diagnosis of sustainability at the building scale

The purpose of the participative system for the diagnosis of sustainability at the building scale is to investigate inhabitants' perception of the quality of housing, outlying areas, and neighborhood relations, thereby facilitating the identification of critical issues and specific priorities at the building scale.

This scheme is designed to provide information concerning building functionality in a way that will complement the technical/objective assessments obtained through established, existing methods. Of the variety of methods and tools taken into consideration and examined, the following have been determined to be fundamental to the assessment:

- the ITACA Protocol [6], an assessment tool deriving from the GB Tool and employed by several Italian regions;
- RET – the *Regolamento Edilizio Tipo* (Reference Building Regulation) of the Emilia Romagna Region, one of the first building regulations in Italy to include sustainability requirements.[7].

This assessment scheme was designed to generate evaluations that take into account both opinions about performance levels expressed by users and technical requirements determined through analytical methods and objective indicators. This makes it possible to draw conclusions about the relationship

between users' perceptions and technical evidence, although this relationship must of course be limited to the sphere of performance issues that can be understood and appreciated by common users possessing no specific technical knowledge.

The method used comprises a questionnaire template, accompanying application protocols, and a calculation tool. The latter is calibrated for the diagnosis of occupied buildings whose inhabitants are called on to express their level of satisfaction with a number of specific issues. The most significant of these are safety and neighborhood relations, as well as comfort, water consumption, and energy consumption.

Questions, which are phrased in a direct fashion, ask about easy-to-understand themes. For instance, for the topic of rational use of resources, users are invited first to express their level of satisfaction with expenses incurred for water and energy consumption. Later, they are asked to supply a separate account of their domestic habits, in an effort to obtain a more in-depth understanding of the overall situation. Finally, users are asked to provide a simple self-assessment regarding the level of sustainability of their own behavior.

Given that the objective of this operation is to acquire information that will be useful during the planning phase of projects, the questionnaire is designed to call attention to users' perception of issues that are critical to quality of life, that concern the physical and structural condition of buildings, and that concern their experience within said buildings. By identifying critical issues, both the data interpretation and the comparative readings of data and technical diagnoses can be simplified. Identifying critical issues can also be particularly useful when budget issues may exert a significant influence on how the project is planned. For instance, when it comes to issues like lack of comfort or safety, users' perceptions often differ from the regulatory notions espoused by designers and managers. If such discrepancies arise, alternative solutions can be proposed in an effort to address the less tangible elements that may be responsible for such discrepancies.

3. Experimental application

These sustainability assessment systems were tested on a largely residential urban district area of Bologna with a prevalence of public housing buildings. The area in question, which is located in the historic and suburban neighborhood of *Navile*, has the characteristics of a consolidated, populated urban environment and has a strong architectural identity. The experiment was conducted in collaboration with the Comune of Bologna and ACER-Azienda Casa Emilia Romagna della Provincia di Bologna (the Local Agency for Public Housing), who provided most of the technical/objective data necessary for the assessment and supported certain application phases of the procedure, from selecting sample buildings to administering questionnaires to the ERP (public housing) users.

The main goal of this experiment was to test and validate certain tools and procedures, and in particular, to verify:

- the functionality of the tools used for the acquisition of technical/objective data
- the clarity and comprehensibility of the questionnaires used in participative surveys
- the accessibility of the data required for assessments, within both systems (especially the technical/objective system)
- the functionality of the calculation model and the reliability of results, within both systems.

Given that the tools in question made reference to a number of analytical scales, and given the peculiarity of a specific set of data that would also be needed for assessment at the neighborhood scale although it had been measured at the building scale, it became necessary for the experiment to delimit an area corresponding to one city block within the previously established district perimeter. This sample block, including the surrounding private and public property, constituted the specific application context

for assessments at the building scale.

The block in question should be seen as a complex comprising buildings, respective appurtenances, perimetric spaces and utility networks. As such, this block represents a micro-urban zone that is a valid sample for the application of the proposed approach from the most detailed projects of small-scale plans to any of several specific projects within complex urban programs.

On the basis of these considerations, this sample block was used to test both the technical/objective assessment system (which was based on analytical indices) and the participative diagnostic system (which was based on questionnaires). The purpose of this experiment was to verify the methods adopted on a significant territorial unit so that these methods could then be applied to other blocks within the same test area.

The first step in the experiment was to acquire the principal data made available by ACER Bologna and the Comune of Bologna (inhabitants' personal information, structural and physical building characteristics, water and energy consumption). This information was integrated with information expeditiously measured in situ concerning the technical characteristics of the buildings, utility networks, and surrounding spaces. Once all the necessary information had been obtained, a set of indicators deemed to be particularly relevant was generated. The next step was to map this set of indicators using a GIS data model: the resulting reading was instrumental to identifying the primary critical issues of the areas and buildings under examination. See figures 2 and 3 for examples of how this data was processed.

Testing the participative tools had two specific goals: to verify the level and quality of interviewee answers, and to verify the assessment results' potential to help define priorities within residential construction projects. Because of the peculiarities of the urban context examined, which was characterized by acute safety and social integration issues, in addition to only containing public housing buildings, the questionnaires were partially modified in order to elicit further information about certain topics (safety, social relations) and less information about others (construction quality).

The system for the participative diagnosis of sustainability at the neighborhood scale was tested on the entire demarcated urban area by directly administering questionnaires and conducting interviews. To that end, the size and composition of the sample of interviewed subjects were established ahead of time, as were the locations deemed appropriate for these interviews. The locations selected were public places that were heavily frequented by the population, e.g. in or near spaces favoring social aggregation, markets, retail locations, public service equipments, squares. In doing so, in addition to inhabitants, the sample of interviewees naturally included people who frequent the neighborhood on a regular or occasional basis, whether for work, play, or to socialize. Including the diverse perceptions of people with distinct reasons for frequenting the area served to enrich the knowledge base that would later be instrumental to the final assessment. (Fig. 4) In contrast, the participative diagnostic system at the building scale was only applied to public housing buildings within the sample block. The experiment was conducted thanks to direct contributions from the Comune of Bologna and ACER Bologna, who were involved in both the design and administration phases of the questionnaires. Given the experimental nature of this activity, particular care was taken to refrain from eliciting a sense of expectation in interviewees. Survey methods included sending questionnaires to inhabitant families (this was done by ACER and the Comune) and subsequently collecting completed forms during pre-announced days and time intervals at service booths set up near building access ways.

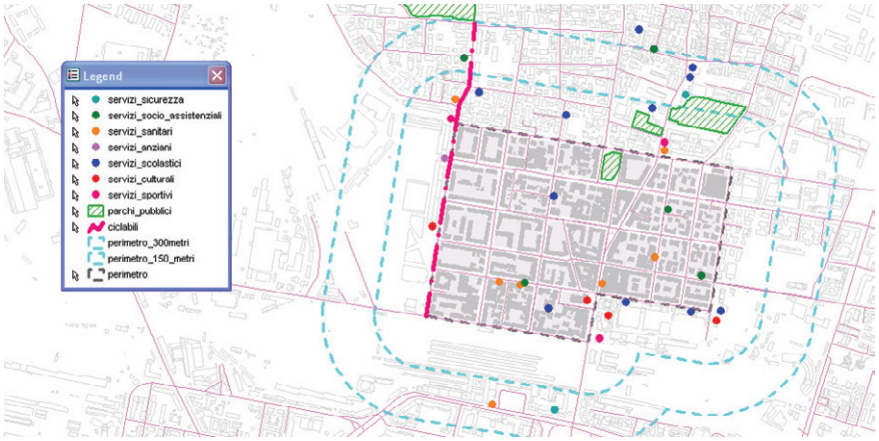

Fig. 2. The urban district used as sample for testing the method

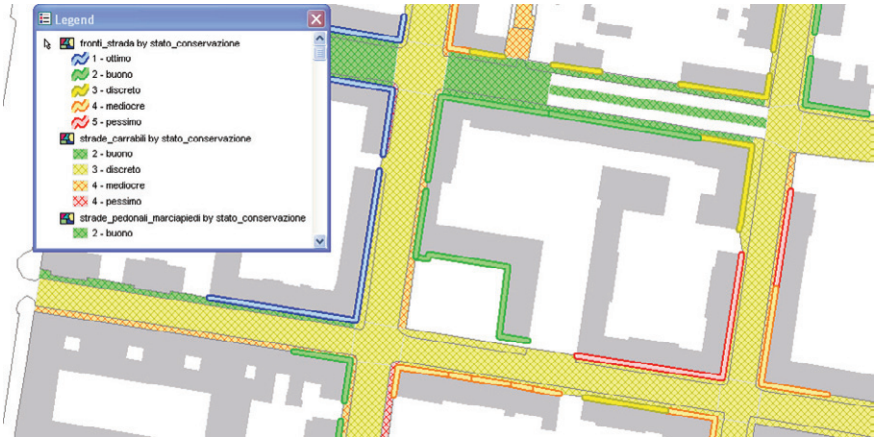

Fig. 3. The experimental block analyzed

4. Conclusion

Our research has shed light on the following phenomenon: while the planning of urban regeneration activities is often characterized by the use of regulatory tools and a heavily profession-centered approach, both users and professionals (including institutional employees) seem to feel the need for solutions that are more suited to grasp the complexity of certain situations, that more successfully take non-technical parameters into account, that involve users in a transparent and effective way, and that better reconcile the needs and constraints of all stakeholders involved.

In accordance with this scenario, entities responsible for construction projects (developers and companies) are forced to meet increasingly higher standards in order to satisfy the demands of government institutions and users, who are becoming more sensitive and discerning. The resulting increase in social and financial responsibilities has generated a need for effective, reliable, and cost-efficient assessment tools.

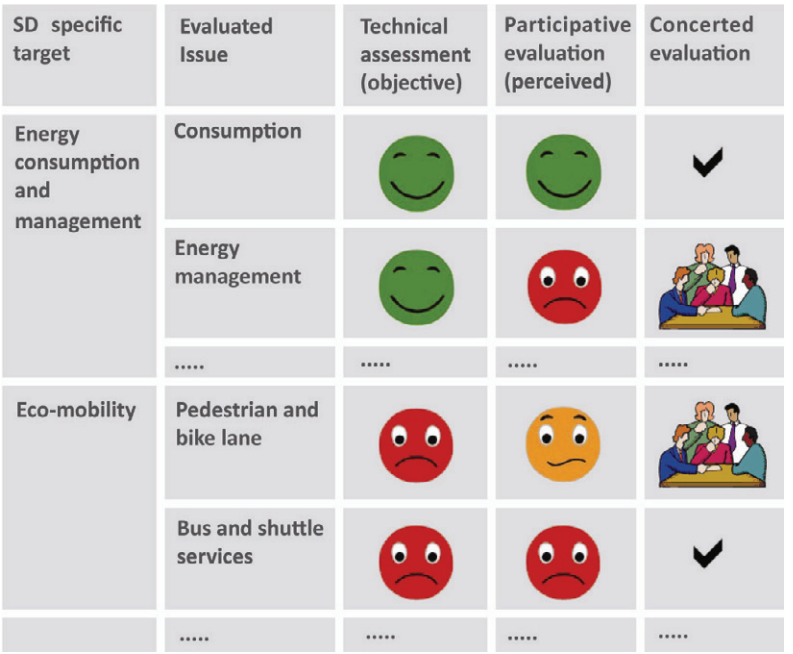

Fig. 4 The concerted assessment process based on combined evaluation of technical and perceived sustainability performances

The assessment procedures and activities often implemented by developers in order to involve users are typically seen as marketing operations that lack the necessary impartiality, transparency, and technical/scientific reliability. As a result, they are rarely successful in effectively generating user involvement. This confirms the validity of the research approach we adopted, which placed great emphasis on defining a formalized method that could provide reliable assessments in a timely, cost-effective fashion.

Our post-experiment reading of the results was influenced by the prospect of future developments. It suggested the need to further ponder two main categories of considerations: the improvement of processes, and the sustainability of rehabilitation projects. [8]

Particularly significant effects could be produced at the urban scale if this assessment procedure were extended to the entire process. An investigation into the relationship between pre-established goals and accomplished solutions would be made possible if verification methods were applied to the following phases: executive planning, implementation, and operations.

As for the sustainable rehabilitation of existing immovable assets, further research into specifically designed assessment methods, which would resolve issues arising from the application of methods intended for new buildings, could deliver promising results.

Finally, this report points to the possibility of implementing a series of actions that would favor the widespread adoption of work methods aiming to make the most of the common ground between individual interests and collective needs. This could be done through the use of concerted and shared tools developed by urban players that would stimulate and regulate cooperation between the public interest (citizens, institutions and administrations) and the private sector (construction industry professionals and companies).

Acknowledgements

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