

Expanding Boundaries: Systems Thinking for the Built Environment



INTEGRATING AN ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT TOOL FOR THE DEVELOPMENT OF BROWNFIELD DEVELOPMENT PROJECTS

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Abstract

In the urban development process, stakeholders (local politicians, businessmen, academics, neighbourhood groups, etc.) involved in urban policies are required to make strategic decisions for their territory in a strategic manner. The available tools are poorly adapted for this process. The evaluation tools most commonly used (LEED, CASBEE, BREEAM and SBTool, etc.) have a complex structure and do not provide the results required in the case of brownfield projects. They do not include the involvement of all stakeholders in the early phases of the project. Moreover, their indicators are not equally distributed among the three dimensions of sustainable development (environmental, social and economic) to reflect the context and local expectations.

This paper presents a transversal and interdisciplinary study on sustainability that examines local indicators that can be used in brownfield projects. The study proposes the construction of an assessment tool derived from an analysis of the methods used in urban development projects.

The study considers a selection of 20 items related to restructuring case studies of North American and European brownfields. A multidisciplinary approach is used to consider the players involved in all phases of the project. The goal is to identify and classify the elements that are needed for decision making, including the indicators related to environmental and socio-economic components, in order to develop an effective evaluation tool.

Keywords:

Sustainable building; brownfield; sustainability assessment; sustainability coverage; subjectivity; adaptability; applicability

1 INTRODUCTION

Urban population has grown rapidly over the last century (US Census Bureau, (World population) 2015 [1]). Also, the demand for land has increased rapidly and the total value of land and real estate has increased steadily over the last 40 years [Isaac, 2002 cited by 2]. Climate change, loss of biodiversity and environmental pollution make it imperative to intervene in the planning of cities and their components (UNEP, 2014 [3]). In the development process of cities, stakeholders involved in urban policies have been called upon to make strategic decisions for their territory [4]. The redevelopment of brownfield sites is now

considered a sustainable land use strategy [5]. Until recently, these sites had been neglected by developers in favour of "greenfields" because of the high costs of soil remediation and the upgrading of existing infrastructure [6]. Our research aims to develop an intervention framework for analysis and decision making.

This paper presents the first part of research that aims to identify the literature for the framework of intervention. Here are the three stages:

(i) Identification of the stakeholders involved in a brownfield redevelopment process and their involvement in the project's phases; (ii) identification of the dimensions covered in each

study and the association of thematic fields; and (iii) identification and classification of indicators for each dimension. This classification is the basis for developing an effective evaluation tool for the redevelopment of brownfield sites.

2 THE CHALLENGES OF UPGRADING BROWNFIELDS

The restoration and redevelopment of brownfield sites can provide economic, social and environmental benefits, including environmental quality restoration, improvement of the quality of life for citizens, improving health, providing land for commercial housing and the creation of employment within the urban environment [7-9]. The link between scientific and local knowledge can contribute to a better understanding of the implications of sustainable development [9, 10]. The assessment tools have become sectoral approaches that consider one dimension over another. The best-known assessment tools, LEED-ND® (North America), BREEAM Communities (UK), SBTool, GreenStar (Australia), and CASBEE-UD (Japan) [11], are voluntary approaches to assess projects according to the project's scale, using their own indicators to achieve certification. Despite their lack of consideration of social and economic aspects [11], these sets of standards contribute to a sound knowledge base but only yield partial results. A true evaluation tool must incorporate all of the sustainable development issues. It must be able to clearly identify the project objectives and classify and prioritize them based on local interests. A new methodological framework (a summary presentation in the form of a table and the list of a project's development criteria) must be built. This methodological framework should be characterized by a multi-criteria, transversal and comprehensive approach to move towards sustainable development. The assessment tools would need to be guided by the normative vision of sustainability, and at the same time be directed towards a framework for the implementation of the users' various requirements [8]. A key factor for success at a local level is the ability to contextualize a project for its city. This contextualization can be achieved through the participation of local stakeholders who can help in the design of policies, plans or projects that best meet the needs of local communities [11]. Experience with participation in strategic planning design and specific local governance by process could reduce the uncertainty associated with future redevelopment and investment promotion [McCarthy, 2002, Nijkamp et al., 2002 cited by 9]. Sustainable development, design issues and project development must be interlinked to create a real process [4].

3 RESEARCH METHODOLOGY

The first part of the research consists of a report on methodological approaches and frameworks; international tools that are completed or under development. The identification of these fundamental elements will identify their roles and their organization in the redevelopment project structure. Our analysis is based on the identification of criteria, targets and indicators. The objectives are to propose a set of criteria that characterize urban redevelopment projects and to carry out the identification of dimensions and stakeholders in order to best select and classify the indicators associated with each dimension.

3.1 The dimensions of identification

Of the 20 selected articles, 13 are based on the three classical dimensions of sustainable development, environmental, social and economic. Only 7 articles stress the importance of adding and evaluating appropriate indicators of socio-cultural dimensions. Addressing only one or two themes is not enough to implement a process for achieving sustainable urban development. As several authors have indicated [8, 9, 12] the objectives of sustainability must be addressed in order to achieve an approach that deals with registering a redevelopment project in the urban fabric in a sustainable way. We chose a combination of thematic and aggregation through an analysis of case studies. This study consists of three phases: 1) A comprehensive inventory of the thematic areas covered in the literature. in order to select the subject areas that encompass all the dimensions of sustainability to be integrated into a neighbourhood project. This inventory of thematic areas consists mainly of existing tools, research, and field work: LEED-ND 2009, BREEAM Communities, CASBEE-UD, SBTool, and Green Star [11]; 2) A selection and aggregation of the thematic areas that are most often discussed in these studies; and 3) A selection of criteria which include sustainability aspects. The choice guided by these criteria can thus classify the thematic fields into three dimensions: environmental, socio-cultural, and economic. These three dimensions are then translated into eight thematic fields, summarized in Table 1.

Dimension	Thematic field
Environmental valuation	Natural Resource Management (Stormwater, sewage, alternative energy, etc.), biodiversity, quality of natural areas
	Environmental protection (floodplains, rivers, lakes, parks, wetlands, animals, etc.)
	Improved comfort and health (site pollution)
Equitable social value and social responsibility	Strengthening cohesion and social equity
	Enhancement of the architectural (buildings and materials) and historical heritage (preservation of historical memory)
Economic strategy	Cost reduction
	Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)
	Multi-functionality of the territory, territorial competitiveness

Table 1: Dimensions and individual thematic fields in articles.

3.2 Identification of stakeholders

Following the literature review (20 relevant articles on brownfield redevelopment) seven stakeholder groups have been identified. The analysis in the articles led us to reflect on the need for a renewal of the identification of the stakeholders involved in a brownfield redevelopment project. Their involvement was classified based on the respective project phases (Table 2). The goal was to identify the level at which each group of stakeholders is involved in decision making. It is in this context that the roles of these stakeholders become more complex and varied. Without going exhaustively into the modality of participation, we can distinguish groups of key stakeholders in a sustainable project process. As shown in Table 2, these actors have been classified into seven groups according to their level of intervention and also in terms of their participation in the project hierarchy according to their discipline. The participation of stakeholder groups in the project phases is essential, but each stakeholder group must contribute specifically at certain phases of a project to achieve a successful sustainable urban redevelopment. We identified two levels of participation: essential and conditional. The first

five stakeholder groups are classified as essential, while the last two groups are considered to have conditional participation in the design phase and project assessment. This latter classification is given to citizens who had not yet been included in the project phases. [7, 10, 11, 12]. This approach puts people at the centre of decision making and permits them to play a decisive role in the evolution of new solutions and to promote sustainability [10, 11].

Group of actors	Public or Private	programming	design	implementing	use
National policy makers	National Policy, Ministerial, administration	x			
Local policy makers	City and community	x	x		x
Institutions and associations	Urban services, service companies, associations, local housing authority, non-governmental partner, academics, building managers	x	x	x	x
Master of private work	Investors, developers, private landlords	x	x		
Master of implementable and experts	Consultants designers, urban planners, sociologists engineers, consultants, experts, renovation agencies	x	x		
Operational actors	Companies, private contractors, technicians, craftsmen		x	x	
Users	Citizens (owner, tenant), neighbors, employees		x	x	x

Table 2: Involvement of stakeholder groups in a project's phases.

This group of players can be a driving force that not only motivates new policy decisions and the actions of professionals, but who also intervene directly in a project [10, 14-19].

4 TOWARD A NEW METHODOLOGICAL APPROACH TO PROJECT EVALUATION

4.1 Selection and classification of indicators associated with their dimensions

Table 3 provides a detailed description of the indicators used in each case study and the objectives identified for each project. By analysing Table 3, it can be observed that the number of indicators considered is different for each author.

Authors	Number indicators		
	Env.	Soc.	Eco.
[20]	1	8	5
[5]	13	8	9
[21]	17	21	13
[22]	10	20	10
[2]	1	1	9
[14]	9	16	8
[23]	2	6	3
[8]	5	5	5
[12]	14	18	8
[24]	4	4	2
[25]	0	0	2
[17]	9	5	8
[18]	7	6	1
[9]	5	4	3
[4]	8	11	7
[26]	4	4	9

Table 3: Indicators and targets used in the literature.

All the models concur that all three dimensions should be covered and that the social and environmental aspects should have a greater amplitude, especially when planning developments affecting brownfield problems. The tools assessed here are not able to adequately assess all three dimensions. Some indicators are related to urban forms yet are not treated with the appropriate tools. Another observation is that the number of indicators becomes less representative in some studies and that project objectives sometimes take the place of indicators. This project evaluation allows us to see the shortcomings of the tools used by

professionals and municipalities, deduced from the intersection of the themes and indicators of the tools used in the case studies.

4.2 Proposed methodological approach

As shown in Fig. 1, the proposed methodological approach consists of three main steps. All the stakeholders involved in the redevelopment process are identified in the first stage.

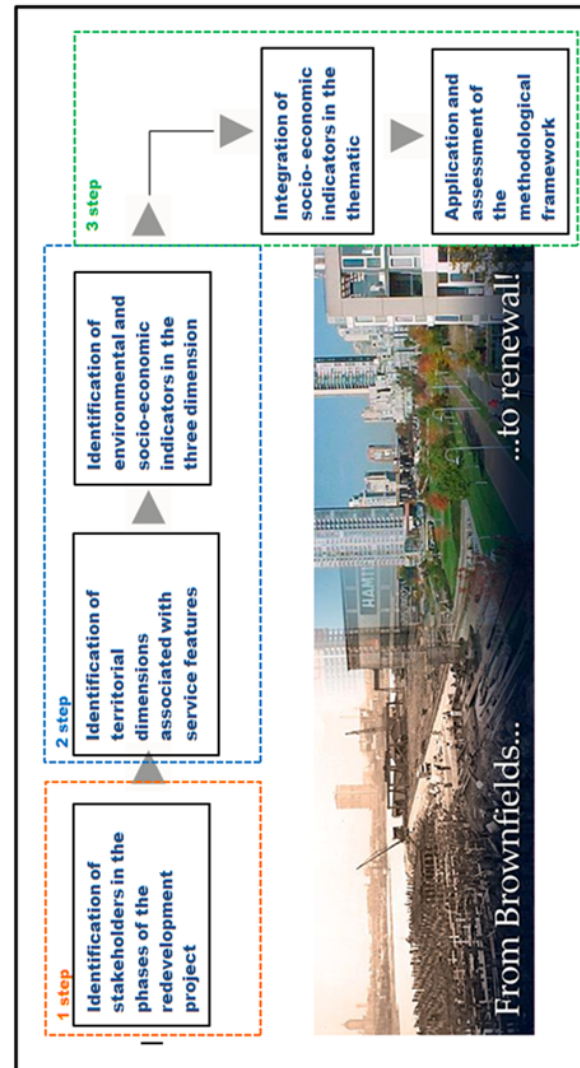


Fig. 1: Methodological approach for the evaluation of a project.

An inclusive vision of stakeholders is incorporated, considering a player as any stakeholder group or individual that is directly or indirectly influenced by the redevelopment process [Freeman, 1984; Mitchel et al., 1997 cited by 9]. In the second phase, the clusters of stakeholders are assembled in a common pattern by a transverse approach. We recognize the interrelationship between the themes in a field, and the various fields that connect the common themes. For example, steps to reduce the consumption of resources lead to reducing project costs, which is also a result of the promotion of sustainable lifestyles in terms of social consumption. This grouping makes it

possible to take into account the linkages and interdependencies between dimensions and themes. In the third step we classify all the themes that we believe are necessary for the redevelopment of a brownfield site. The purpose of this approach is to establish the level of complexity of the brownfield problem and also to form a structure of criteria with which to establish the actions to be taken to achieve the redevelopment. To proceed with the integration of aspects of sustainable urban development, the working method is to cross the dimensions with the project's parameters to translate the objectives for a project's development. From these crossings eight thematic fields will be selected in order to identify the issues to consider for successful integration. Table 4 shows the linking of eight thematic fields with the parameters of the redevelopment project. It is

assumed that between the themes and phases of project design, there are links to arrive at intelligent redevelopment objectives. For example, architectural heritage enhancement is related to urban form and to the historic preservation of buildings. There is also a link to the multi-functionality of services, the use of the territory and the social relations of citizens and economic activity at the industrial site.

The objective is therefore to contribute to brownfield redevelopment by transforming the traditional project criteria to support a sustainable redevelopment approach in which stakeholders use these criteria as the basis of communication with other stakeholders.

	Thematic field	Redevelopment settings
Environmental valuation	Natural Resource Management (Stormwater, sewage, alternative energy, etc.), biodiversity, quality of natural areas	Infrastructure system water; Water consumption (including water quality); Energy consumption; Green spaces; Water surface; Vegetation
	Environmental protection (floodplains, rivers, lakes, wetlands, parks, animals, etc.)	Use of space; Living areas; Landscape (unnatural barrier, bridges, viaducts); Enhancing biodiversity; Morphology; River system
	Improved comfort and health (pollution of the site)	Ventilation; Physical comfort; Proportion of own sites; Soil quality; Lighting
social Equitable value/social responsibility	Strengthening cohesion and social equity	Accessibility; Public spaces; Density; Distribution services; Inclusion; Security
	Enhancement of the architectural (buildings and materials) and historical (preservation of historical memory) heritage	Structure; Materials; Technology; Protection; Care and maintenance; Form; Architectural fragmentation; Architectural quality
Economic strategy	Cost reduction	Waste management; Distribution functions; Service – Business; Contiguity;
	Increase of cohesion (accessibility and transportation) and economic dynamics (employment and business)	Streets network; Public transport; Fluidity of movement; Parking; Links, connections; Economic diversification
	Multi-functionality of the territory, territorial competitiveness	Location; Connections; Partition areas; Urban form (urban fabric); Public areas; Historical activities

Table 4: Redevelopment settings.

The list of criteria is based on two groups of data: All the themes proposed for sustainable redevelopment early in our analysis were expressed as a set of criteria for the design of a sustainable industrial redevelopment (see Table 4). This was done to meet the goals (thematic). In

practice, by crossing each theme with each parameter we were able to establish the integration criteria. This was done with the intention to collect and consolidate criteria that meet different objectives with the parameters of design and also assemble the same practical criteria.

5 DISCUSSIONS

Thus far, the study has only revealed partial results, as there is not much specific literature that considers the tangible socio-economic aspects in brownfield development. Most studies that consider environmental issues prioritize soil contamination and decontamination. New criteria are essential for sustainable development solutions, and in this case, for the reuse of industrial sites. The tools used by professionals and municipalities have their shortcomings in terms of project evaluation. A tool must be able to clearly identify a project's objectives and to classify and prioritize them based on local interests. The need for regeneration of the natural environment, including the landscape and biodiversity, must be a priority [12]. The quality of brownfield conversion needs to consider users' expectations for the rehabilitation of these sites. We believe that the value of these sites and their re-appropriation for productive use must be taken into consideration. This can be attained through the use of suitable indicators. As stated by [Williams et Dair (2007) and Ballesteros et Ramirez (2007) cited from 9] attachment to cultural heritage must be among the objectives of redevelopment projects because of the influence of the concepts of landscape and the social aspects of the community. The indicators related to the conditions of public safety, accessibility, etc. also need to be part of the redevelopment of brownfields [6, 8, 9, 12]. A new methodological framework characterized by a multi-criteria, transversal and comprehensive approach is a requirement for moving towards sustainable redevelopment.

6 CONCLUSIONS AND FUTURE WORK

The sustainable development approach has led to a renewal of the conceptual issues of project development. The new criteria resulting from the crossing of thematic issues with the parameters of project design allow for better control of a project's implementation. These improvements are especially notable in the early stages of programming and project design. However, it is interesting to note that the success of such an approach in the context of a development project depends on the contributions of all of a project's stakeholders, and not only on national and local policy makers. This is clearly demonstrated in the results of our crossing the thematic issues with project parameters: project development criteria fail to address several issues that are required for a successful urban redevelopment. We prefer to leave the methodology open to supplementary and continuous evolutions. Without a proper system of checks and balances, the methodology will never improve. Checks and balances are necessary to validate the developed tools.

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8 REFERENCES

1. <http://www.census.gov/> (visited page 14.12.2015)
2. Chen, Y., et al., *A strategic classification support system for brownfield redevelopment*. Environmental Modelling & Software, 2009. **24**(5): p. 647-654.
3. <http://www.unep.org/annualreport/2014/en/index.html> (visited page 13.12.2015)
4. Bartke, S. and R. Schwarze, *No perfect tools: Trade-offs of sustainability principles and user requirements in designing support tools for land-use decisions between greenfields and brownfields*. Journal of Environmental Management, 2015. **153**: p. 11-24.
5. Thomas, M.R., *A Weighted, Multi-Attribute, Site Prioritization and Selection Process for Brownfield Redevelopment*. Environmental Practice, 2002. **4**(02): p. 95-106.
6. Thomas, M.R., *A GIS-based decision support system for brownfield redevelopment*. Landscape and Urban Planning, 2002. **58**(1): p. 7-23.
7. Bramley, G. and S. Power, *Urban Form and Social Sustainability: The Role of Density and Housing Type*. Environment and Planning B: Planning and Design, 2009. **36**(1): p. 30-48.
8. Pediaditi, K., K.J. Doick, and A.J. Moffat, *Monitoring and evaluation practice for brownfield, regeneration to greenspace initiatives: A meta-evaluation of assessment and monitoring tools*. Landscape and Urban Planning, 2010. **97**(1): p. 22-36.
9. Sardinha, I.D., D. Craveiro, and S. Milheiras, *A sustainability framework for redevelopment of rural brownfields: stakeholder participation at SÃO DOMINGOS mine, Portugal*. Journal of Cleaner Production, 2013. **57**: p. 200-208.
10. Moussiopoulos, N., et al., *Environmental, social and economic information management for the evaluation of sustainability in urban areas: A system of indicators for Thessaloniki, Greece*. Cities, 2010. **27**(5): p. 377-384.
11. Sharifi, A. and A. Murayama, *Neighborhood sustainability assessment in action: Cross-evaluation of three assessment*

systems and their cases from the US, the UK, and Japan. *Building and Environment*, 2014. **72**: p. 243-258.

<http://www.usgbc.org/guide/nd> (visited page 03.12.2015)

12. Schädler, S., et al., *Designing sustainable and economically attractive brownfield revitalization options using an integrated assessment model*. *Journal of Environmental Management*, 2011. **92**(3): p. 827-837.

13. Nijkamp, P., C.A. Rodenburg, and A.J. Wagtendonk, *Success factors for sustainable urban brownfield development: A comparative case study approach to polluted sites*. *Ecological Economics*, 2002. **40**(2): p. 235-252.

14. Doick, K.J., et al., *Understanding success in the context of brownfield greening projects: The requirement for outcome evaluation in urban greenspace success assessment*. *Urban Forestry & Urban Greening*, 2009. **8**(3): p. 163-178.

15. Cohen, A., *Achieving Healthy School Siting and Planning Policies: Understanding Shared Concerns of Environmental Planners, Public Health Professionals, and Educators*. *NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy*, 2010. **20**(1): p. 49-72.

16. Chrysochoou, M., et al., *A GIS and indexing scheme to screen brownfields for area-wide redevelopment planning*. *Landscape and Urban Planning*, 2012. **105**(3): p. 187-198.

17. Chrysochoou, M., et al., *Reversing urban sprawl: A reclaimability index approach for reviving downtown Brownfields*. No. CTLS, 2011: p. 08-03.

18. Cappuyns, V. and B. Kessen, *Evaluation of the environmental impact of Brownfield remediation options: comparison of two life cycle assessment-based evaluation tools*. *Environmental Technology*, 2012. **33**(21): p. 2447-2459.

19. Luederitz, C., D.J. Lang, and H. Von Wehrden, *A systematic review of guiding principles for sustainable urban neighborhood development*. *Landscape and Urban Planning*, 2013. **118**: p. 40-52.

20. Greenberg, M. and M.J. Lewis, *Brownfields Redevelopment, Preferences and Public Involvement: A Case Study of an Ethnically Mixed Neighbourhood*. *Urban Studies*, 2000. **37**(13): p. 2501-2514.

21. De Sousa, C.A., *Turning brownfields into green space in the City of Toronto*. *Landscape and Urban Planning*, 2003. **62**(4): p. 181-198.

22. Wedding, G.C. and D. Crawford-Brown, *Measuring site-level success in brownfield redevelopments: A focus on sustainability and green building*. *Journal of Environmental Management*, 2007. **85**(2): p. 483-495.

23. Brill, C.W., *using GIS to contrast perceived versus preferred priorities for Brownfield redevelopment in worcester, massachusetts*. *URISA Journal*, 2009. **21**(2): p. 49.

24. Rall, E.L. and D. Haase, *Creative intervention in a dynamic city: A sustainability assessment of an interim use strategy for brownfields in Leipzig, Germany*. *Landscape and Urban Planning*, 2011. **100**(3): p. 189-201.

25. Yu, S., et al., *Allocating risk capital for a brownfields redevelopment project under hydrogeological and financial uncertainty*. *Journal of Environmental Management*, 2012. **100**: p. 96-108.

26. Beekmans, J., et al., *Countering decline of industrial sites: Do local economic development policies target the neediest places?* *Urban Studies*, 2015.