Evaluation of Land Use and Environmental Comfort in Reinventing Cities Competition: The Case of La Folie, Bobigny, France

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Abstract. The growing anthropogenic pressure on cities in recent years requires the adoption of a holistic approach to address the climatic adversities resulting from human activities. Taking into account the multifaceted impacts of urban expansion, spanning social, physical, ecological, and technological dimensions, this study focuses on devising a hybrid methodology to assess these implications consistently.

Using the Reinventing Cities area "La Folie" in Bobigny, France, as a case study, this methodology aims to regenerate abandoned urban spaces into vibrant community hubs while mitigating negative burdens such as gentrification, social segregation, and environmental degradation. By combining the Analytic Hierarchy Process (AHP) model and SWOT + STEEP analysis with Stakeholder Analysis and Scenario Building, this approach facilitates comprehensive examination of various factors, addressing the complexities of global issues. Through the evaluation of economic, social, comfort, and environmental implications based on built surface area and soil use percentages, the model seeks to advocate for alternative methodologies that promote sustainable development. By clarifying stakeholders' perspectives, decision-makers are equipped with a robust framework to navigate conflicting goals and make informed decisions, fostering the dissemination of innovative techniques conducive to sustainable development paradigms. Eventually, the findings indicate that 60% of built area is the suggested ratio for a well-designed infill development that takes into account all the implications above, as well as soil sealing effects.

Keywords: Analytic Hierarchy Process (AHP) · infill development · soil sealing · multidisciplinary decision making · land use

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1 Introduction

Rapid urban expansion is a process occurring across many regions of the world. Since 2008, the global populations have shifted from mostly rural to urban, [1, 2] and this trend is expected to continue, with the latter projected to reach 6.3 billion by 2050 [3]. This rapid urbanization across the globe poses significant challenges, including environmental, socio-economic, and spatial ones.

The driving forces behind this phenomenon primarily stem from the beneficial impact cities have on economic growth and technological innovation [3].

In the past years, the fast pace of urbanization led to a high need of new zones for residential spaces, public facilities, commercial ventures, and other urban land uses. Nonetheless, the lack of clear urban limits has resulted in the emergence of urban sprawl, which in turn led to an increase in various issues such as commuting distances and consequent traffic volume, air pollution, anthropogenic impact, and loss of open land. The expansion of a city's perimeter is unavoidable up to a certain point in its development, however, the continuous increase of urban limits cannot persist indefinitely, as reached a certain threshold it becomes a catalyst for the challenges described above [4].

In recent years, greater focus has been placed on sustainable urban development and the concept of smart growth, which comprises different urban expansion principles opposed to urban sprawl, such as mixed land use, infill development, pedestrian-scaled design, transit-oriented design, and preservation of open space [5, 6].

Urban densification is being supported in many European countries as a strategy to reduce air pollution, automobile dependency and the consumption of land [7]. Even though increasing density is a crucial component for contributing to sustainable development, it is insufficient for tackling the critical challenges of our time. For compact growth initiatives to be successful, for example, it is crucial to examine how they will impact local amenities and the way in which residents perceive these effects [8].

In this paper we investigate the possible advantages of a de-sealing strategy through a multi-level methodology analysis. For doing that, we examine which is the optimal land cover percentage for promoting the infiltration process of rainwater into the ground by taking into account four different criteria: 1) Environmental healthiness, 2) Comfort, 3) Profitability, 4) Social fabric. As a result, a reduction in soil sealing helps mitigating urban heat island (UHI) effects, recharge groundwater aquifers, and reduce the risk of flooding, contributing to healthier, more livable urban environments.

The following chapters discuss in detail the methodology and lessons learnt from the case study. In Sect. 2 we define the methodology for developing a multi-criteria analysis, composed by a Stakeholder Analysis, a SWOT + STEEP Analysis, a Scenario Building to delineate the decision problem and a multi-level ranking technique "AHP" for evaluating and resolving the problem. Finally, Sect. 3 consists in the application of the methodology to a case study and Sect. 4 discusses the research outputs and sets some concluding remarks.

2 Integrated Multi-level Methodology

The multi-level methodology integrates various evaluation models aimed at supporting the assessment of policies, plans, and projects within urban transformations. Recognizing the complexity inherent in urban design processes, characterized by multiple stakeholders and conflicting values, the integrated assessment paradigm is proposed to combine different approaches.

The proposed methodology follows three main phases: problem framing, construction of alternative scenarios, and evaluation of the problem for the selection of the best alternative [9].

The research focuses on this methodology to address the more sustainable choice for the case study regeneration.

2.1 Framing of the Problem

During the problem-framing phase, a broad analysis of the case study is conducted alongside Stakeholder Analysis to understand the involved actors and their potential support or opposition to strategies, to make them effective [9, 10].

A Stakeholder Analysis is necessary in the field of urban development to identify and analyse the interests of organizations and individuals who have a stake in or can influence urban development projects. The complex challenges faced today, including rapid population growth, climate change, and resource limitations, necessitate addressing diverse interests among stakeholders. Thus, determining which stakeholders should be involved in urban development projects poses a dilemma for decision-makers [11]. Developing frameworks to identify and map stakeholders is necessary for addressing societal challenges comprehensively [10].

The first step for this mapping involves categorizing stakeholders according to certain attributes. This includes determining their scope of influence (whether it is national, regional, or local), categorizing their affiliation (whether they are political, bureaucratic, special interest, general interest, or experts), and assessing the resources they wield (such as political, economic, legal, or cognitive resources). Additionally, it entails understanding their roles and expectations within the context of the analysis [12].

Once mapped, obtaining a comprehensive understanding of stakeholders' concerns, and managing conflict requires practical analysis methods [11].

In this research, a combination of the Power-Interest Matrix (P/I) and the Social Network Analysis (SNA) is proposed to evaluate stakeholders.

Power/Interest Matrix. Power/Interest Matrix is an evaluation tool to categorize stakeholders based on their level of power and interest in the project. By plotting stakeholders on the power/interest matrix, project teams can prioritize their engagement strategies and tailor communication and management approaches, ensuring that key stakeholders are effectively engaged, and their concerns are addressed throughout the project lifecycle [13].

Social Network Analysis. Social Network Analysis (SNA) offers a dynamic lens through which to understand social structures. Rooted in sociology and anthropology, it emphasizes the intricate web of relationships between stakeholders within a network. By identifying and analysing these relationships, SNA provides actionable insights for improving collaboration, communication, and decision-making within the network. Through visual representation and quantitative analysis, SNA enables stakeholders to grasp the complexity of their networks and identify key influencers, connectors, and hubs. This facilitates informed decision-making and strategic planning, enhancing overall network effectiveness [11].

2.2 Alternative Scenario Construction

Strategic planning using scenarios has gained significant traction in recent decades, highlighting the need for more effective long-term policies. Since the early 1980s, efforts have been made to integrate prospective and strategic planning [14].

This integrated approach, designed to guide companies in formulating strategies based on realistic and contextually sustainable forecasts, can also be applied to urban and regional planning for the adoption of sustainable policies and plans [9, 14].

SWOT + STEEP Analysis. The SWOT analysis, originating from research conducted in the 1960s, is a strategic planning tool used to assess internal strengths (S) and weaknesses (W), as well as external opportunities (O) and threats (T) [15].

Originally emerged as a response to the shortcomings of corporate planning in managing change effectively, this methodology has evolved into a widely used strategic planning tool applied across various fields, including urban and territorial development [15, 16].

Methodologically, the SWOT analysis appears as a four-quadrant matrix that distinguishes between existing endogenous factors, which are variables within the system that can be directly modified, and possible exogenous factors, which are external variables influencing the system [9, 16].

SWOT Analysis is often paired with complementary tools to enhance and structure outcomes more effectively, such as the STEEP Analysis (STEEP + SWOT). STEEP Analysis encompasses the components of Society (S), Technology (T), Environment (E), Economy (E), and Policy (P), evaluates various facets within a given context. This comprehensive SWOT + STEEP analysis, provides insights into the intricate dynamics of critical areas and is a newer method utilized in decision-making processes to offer a clearer understanding of the influential factors shaping potential objectives and transformation scenarios [9].

Dynamic SWOT. The traditional SWOT analysis fails not relating its elements to each other. Thus, the Dynamic SWOT introduce pairwise comparisons between all identified elements, regardless of category, allowing for a more comprehensive understanding of relationships and identification of predominant factors, and enabling a more in-depth and dynamic analysis of the evaluated situation [17].

The procedure involves creating a square matrix containing all identified elements, then conducting pairwise comparisons between each row element and each column element. Then a value indicating the degree of synergy between the two compared

elements is assigned. This process provides a clearer understanding of the relationships between the elements and identifies which ones are predominant and have a greater influence on others. Overall, Dynamic SWOT provides a more effective approach to evaluative analysis [17].

Scenario Building. Scenarios serve as a valuable tool for organizations to anticipate potential future situations, fostering flexibility and innovation. They offer descriptions of future situations and events, aiding in the transition from present to future states [18].

By incorporating the interests of all stakeholders, this approach fosters political consensus [9].

In scenario planning, a finite number of scenarios for future transformations is considered, typically ranging from three to five. This approach allows decision-makers to compare different scenarios and facilitates the transition towards sustainable integrated spatial planning [9, 18].

2.3 Evaluation of the Problem

In the problem evaluation phase, the constructed scenarios are assessed to investigate the most sustainable alternative.

Decision-making involves the selection of criteria and alternatives. [19] Among the different multicriteria methods, the Analytic Hierarchy Process (AHP) is chosen.

Analytic Hierarchy Process (AHP). The Analytic Hierarchy Process (AHP), proposed by Saaty in 1980, stands as a pivotal method in multicriteria decision-making, offering a comprehensive framework for handling complex decisions by facilitating comparisons among different options. Grounded in a multi-criteria measurement theory, AHP enables the derivation of relative priority scales on absolute scales, regardless of whether the comparisons are discrete or continuous within a multilevel hierarchy structure [20, 21].

AHP encompasses both tangible and intangible elements in evaluations, integrating real data and expert subjective decisions. Following the AHP methodology, complex problems are dissected into sub-problems organized hierarchically. Each level of the hierarchy represents a set of criteria or attributes related to its respective sub-problem, with the top level denoting the overarching goal and intermediate levels signifying factors from upper levels. Alternatives or actions to achieve the goal are situated at the bottom level [20].

The AHP analysis operates on three fundamental principles [21].

1. Problem Decomposition: The decision-making problem is broken down into hierarchical levels, establishing unidirectional hierarchical relationships from the top (objective) to the bottom (alternatives).
2. Pairwise Comparison: Decision elements are compared pairwise concerning their importance for their controlling criterion. Decision-makers provide relative importance values using a 9-point scale, known as “Saaty’s Fundamental Scale”.
3. Synthesis of Preferences: After constructing comparison matrices, relative weights of elements within each level are computed using the eigenvector associated with the largest eigenvalue of their comparison matrix. Consistency is measured using Saaty’s consistency index (CI) and consistency ratio (CR), with CR values below 0.1 considered acceptable.

AHP has gained widespread acceptance in the international scientific community as a robust and flexible multi-criteria decision-making tool. It finds applications in various domains, including hydropower systems, for impact evaluation, risk analysis, financial evaluation, and assessment of alternative projects [21].

3 Application

The process described in the previous chapter was therefore applied to the case study under analysis. Figure 1 shows the methodological pipeline used.

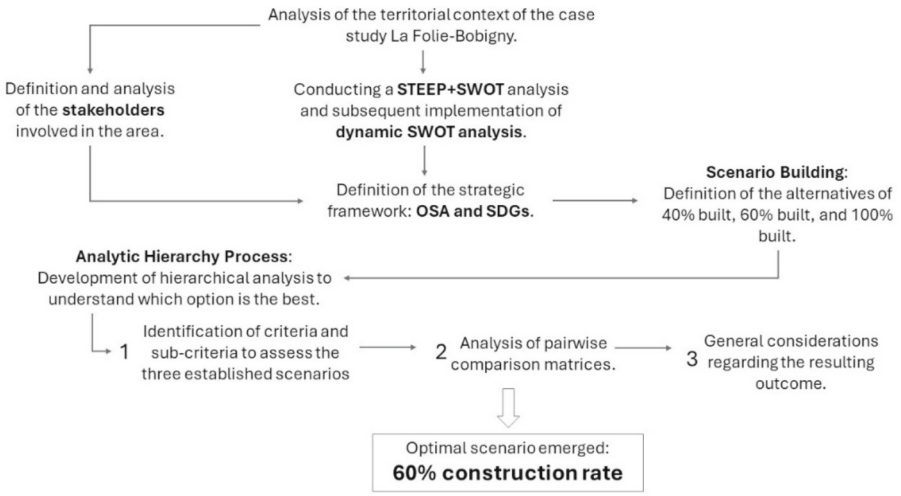


Fig. 1. Methodological pipeline synthesis.

3.1 Case Study: La Folie – Bobigny

The area under investigation is located in the southern part of the municipality of Bobigny, in the northeast outskirts of Paris. The territory is situated in the small Parisian crown, within the Île de France region, and falls within the inter-municipal structure of Est Ensemble, as shown in Fig. 2.

Specifically, the study area is part of the broader planning area of Plaine de l'Ourcq, a plain named after the canal that runs through the municipality of Bobigny. The urban context of this area, characterized by an industrial and logistical past, is currently influenced by significant infrastructures such as the Meaux road (formerly RN3), the A86/63 highway network, and the railway.

Additionally, the project area is part of a series of territorial development plans called ZAC (Zone of Concentrated Development) and, more specifically, falls within the framework of the ZAC Ecocité plan. The latter aims at the redevelopment of the banks

of the Canal de l'Ourcq and the reconstruction of the urban fabric, contributing to the overall progress of the area.

The project area was involved in the 2018 Reinventing Cities (RC2018) competition, which proposed the development of a mixed-use commercial and residential project. This entailed creating active ground floors, functions at a metropolitan scale (such as hotels, services, commercial activities, and logistics), and the construction of a pedestrian bridge over the canal. The stated objectives in the competition were as follows:

Making the Canal Visible in the Metropolitan Context of Grand Paris: Recognized as a historically significant element and a pillar of territorial identity, the project aims to enhance the canal as a unifying element, serving as a lever for significant urban transformation. The goal is to improve the green and blue landscape, creating an exemplary place that enhances panoramic views and becomes an urban landmark. The canal is envisioned to become the focal point for new metropolitan uses, including active mobility, river ports, recreational activities, and artistic and craft production.

Redesigning the Connection with the Canal and Transforming RN3 into an Urban Boulevard: The idea is to orient the city towards the canal while simultaneously maintaining existing economic activities. The project aims to create new canal crossings, particularly near the new La Folie station (M5, T11 Express, Cable Car), through the construction of footbridges or the restructuring of existing major crossing structures such as the Pont de Bondy.

Requalifying Urban Attractiveness and Giving a New Impetus to Economic Activity: The conversion of single-purpose industrial buildings and areas is seen as a key opportunity for urban and economic revitalization. Plaine de l'Ourcq aspires to become a territory that promotes a mix of urban and functional uses, also serving as a laboratory for innovation and experimentation in smart city concepts. Intensifying economic programs, with a focus on tourism, daily activities, culture, and sports, including the implementation of the concept of "rez-de-chaussée actifs" (active ground floor), will contribute to making the canal attractive through a diversification of uses.

Moreover, the objective is to determine the optimal scenario for promoting redevelopment and good design from a social, economic, and environmental perspective, with particular attention to sustainability and climate resilience, closely tied to the amount of land occupied by the new project and its consequent soil sealing effect.

The integrated method is then applied to the project area, starting with cognitive analysis, and concluding with scenario selection, we take into account how much land will be occupied by the built part and what percentage will remain undeveloped. Managing the intrinsic complexity and contradictions of the area represents the most challenging aspect of the decision-making process.

Stakeholder Analysis. Once the key stakeholders were identified (Fig. 3), they were categorized based on their level of influence and interest using the Power/Interest matrix, as shown in Fig. 4.

Based on the Social Network Analysis (SNA) model, this analysis was integrated with an examination of existing and potential relationships among the involved actors, as shown in Fig. 5.

As previously mentioned, the area in question underwent the RC2018 tender, through which the Municipality of Bobigny decided to promote the redevelopment of the Folie

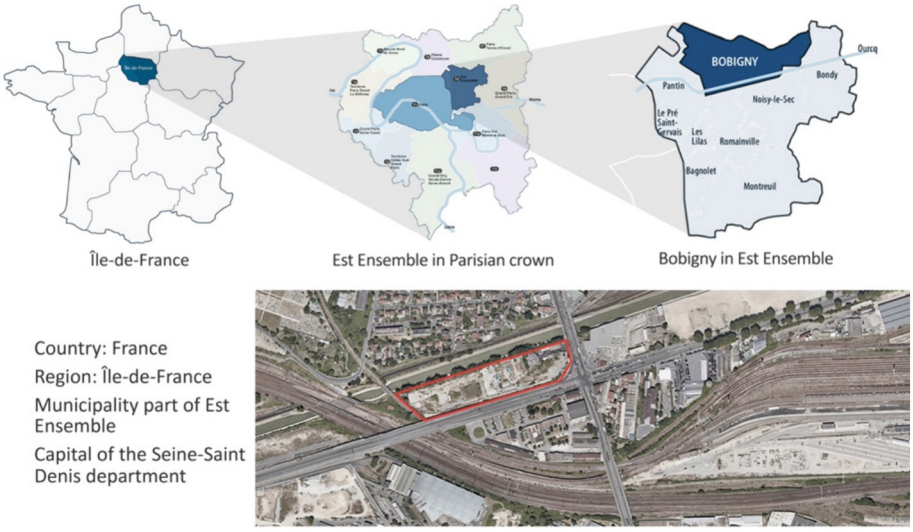


Fig. 2. Description of the area

area. The allocation of the area was entrusted to the company Sequano Amenagement, tasked with preparing it for subsequent development.

Upon completion of the design phase and the establishment of a purchase agreement for the area by the winning team, the project will be implemented through a public-private partnership. In this context, the winning team will bear all the construction and remediation costs of the area, while the Municipality will cover expenses related to the redevelopment project.

Based on this scenario, the various stages of the process were identified: Start, preliminary, executive, construction, end of work and building use. Subsequently, three methodologies of representation and analysis were employed to map the project's stakeholders.

Initially, using the matrix typology, a list of the main stakeholders was compiled to verify their presence in different phases. Subsequently, after the actors actively involved in the decision-making process were identified, they were categorized based on level (national, regional, or local) and type (political, bureaucratic, special interests, general interests, and experts). This phase of actor identification enabled careful monitoring of categories of individuals with greater potential influence on the project at all its stages.

The involvement in the decision-making process is crucial for all other actors and stakeholders, each with different degrees of engagement based on the quadrant they occupy. This is imperative to ensure maximum transparency and foster the acceptance of decisions across all involved parties. The successful implementation of this strategy is the key to minimizing and alleviating conflicts stemming from differing opinions, thereby enhancing the prospects of intervention success.



Fig. 3. Stakeholders and actors list, divided by Dente's (2014) criteria.

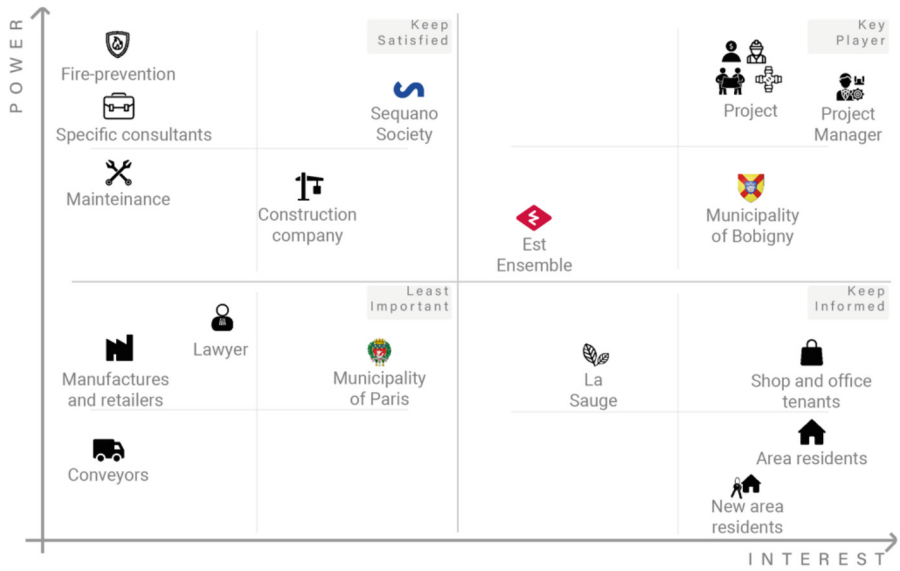


Fig. 4. Output of P/I Stakeholders Analysis.

3.2 SWOT + STEEP Analysis

The combined utilization of SWOT analysis and STEEP analysis, as we can see in Table 1, facilitated the recognition of the distinctive features of the intervention area.

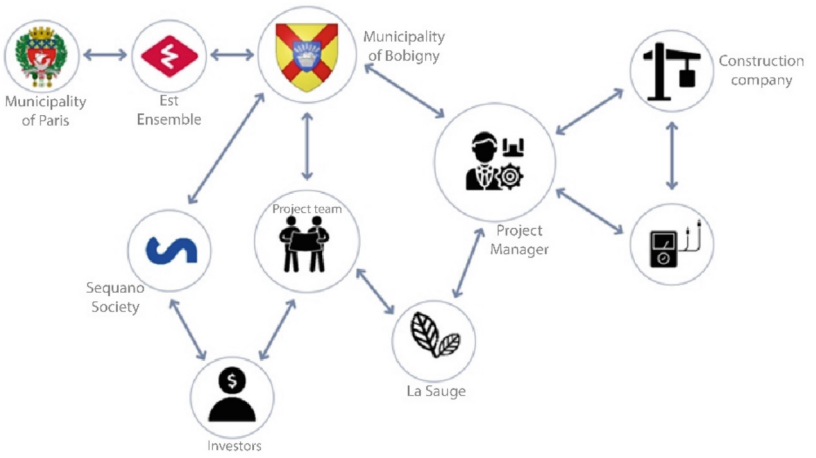


Fig. 5. Output of SNA Stakeholders Analysis.

Regarding strengths, the green areas near the project site and the presence of neighbourhood services have been positively highlighted. However, significant weaknesses have been underscored in the form of noise pollution. Concerning opportunities, potential points for expanding public transportation lines have been identified. Simultaneously, risks have been noted, including the degradation and abandonment of industrial buildings and green areas.

Understanding the territorial context and its characteristics has been crucial as support in the critical phase of developing the Dynamic SWOT Analysis. It was chosen to present a summarized representation of the dynamic SWOT analysis, encapsulating the fundamental comparison process underlying the conducted analysis (Fig. 6). Only a portion of the comparison performed was depicted, focusing specifically on the comparison between the strengths and weaknesses analysed.

Beginning with the STEEP approach, the initial step involved associating an identification code with various categories within the analysis sectors. Subsequently, the matrix of the dynamic SWOT analysis was structured, aiming to compare each row element with every column element through binary comparison, assigning a rating from +2 to -2. In this structure, influenced elements are represented in the rows, while influencing elements are in the columns.

3.3 Strategic Framework: OSA and SDGs

Through the SWOT + STEEP analysis, various perspectives of future scenarios have been outlined, focusing on the development of goals, strategies, and actions (OSA) aimed at guiding the design phase with maximum effectiveness. From the SWOT + STEEP analysis, three key factors have emerged to integrate into the design phase, with specific attention given to environmental goals, the redevelopment of connections, and the creation of an attractive hub acting as a network of attraction for the entire Est Ensemble region. This has led to the definition of the following objectives:

Table 1. Output of the SWOT + STEEP Analysis.

	STRENGHTS	WEAKNESSES	OPPORTUNITIES	THREATS
SOCIETY	S.S.1: Presence of mixed population groups S.S.2: Proximity to residential neighbourhoods	S.W.1: Homelessness S.W.2: Uninhabited areas S.W.3: Social imbalances	S.O.1: Multiculturalism and its promotion through artistic and musical activities	S.T.1: Conflicts and social degradation S.T.2: Difficulties of integration between different communities
TECHNOLOGY	T.S.1: Presence of urban agriculture association La Sauge T.S.2: Presence of specialised labour in industrial sectors	T.W.1: Scarce presence of tourist attractions T.W.2: presence of abandoned industrial areas T.W.3: Presence of old industrial buildings	T.O.1: Extension of the city on the canal with extension of services and facilities T.O.2: Connection to the geothermal heating network	T.T.1: Mass construction to meet housing demand resulting in gentrification T.T.2: Further degradation and abandonment of industrial areas
ENVIRONMENT	A.S.1: Vegetation along the area-boundaries A.S.2: Presence of the Canal de l'Ourcq A.S.3: Upgraded urban green areas A.S.4: Presence of natural interest areas	A.W.1: High traffic levels A.W.2: Presence of abandoned green areas A.W.3: Presence of industrial waste	A.O.1: Introduction of biodiversity awareness areas and life trails. A.O.2: Maintenance of La Sauge association A.O.3: Promotion of zero-impact agricultural production activities	A.T.2: Degradation and abandonment of green areas and vegetation along the canal

(*continued*)

Table 1. (*continued*)

	STRENGHTS	WEAKNESSES	OPPORTUNITIES	THREATS
ECONOMY,	E.S.1: Presence of industrial activities E.S.2: Presence of logistics centres	E.W.1: Brownfield areas with untapped economic potential. E.W.2: Single-functionality neighbourhoods E.W.3: Lack of services	E.O.1: Transport of goods along the canal E.O.2: Valorisation of empty spaces through active ground plans E.O.3: New hotel development	E.T.1: Non-activation of urban regeneration processes E.T.2: Difficulty in activating, urban regeneration processes for economic reasons and soil pollution
POLICY	P.S.1: Strategic location P.S.2: Presence Ecocité ZAC plans for redevelopment	P.W.1: Difficulties in implementing bureaucratic projects due to low participation	P.O.1: New T11 and TZen3 tram line stops, and new M5 metro line stop to connect with Paris	P.T.1: Expansion projects regardless of social impacts
MOBILITY	M.S.1: Dense public transport network at local scale M.S.2: River ports M.S.3: Proximity to CDG airport	M.W.1: No large-scale connection with Paris M.W.2: Lack of protected pedestrian M.W.3: Lack of cycle paths M.W.4: High noise pollution from rail traffic	M.O.1: Expansion of north-south transverse routes with canal bank connection M.O.2: Introduction of car-sharing and bike-sharing services	M.T.1: Strong increase in traffic along the main arterial roads and consequent increase in pollution

01. ENVIRONMENT: Improve the quality of public green spaces through interventions aimed at reducing noise and environmental pollution, reconfiguring the use of green spaces, and connecting existing parks. The interventions are oriented towards creating a network of paths and public green spaces that promote connection and cohesion.

02. CONNECTIONS: Improve the connectivity of the area, both from a physical-infrastructure and visual perspective. An effective and widespread system of connections allows for extending the opportunity to participate in the life and events of the neighbourhood to all individuals.

03. NETWORK: Enhance the functional offering present in the La Folle area and surrounding neighbourhoods. This objective not only aims to strengthen the existing



Numerical scale	Description
-2	The element in the row is strongly hindered, or even canceled out, by the element in the column.
-1	The in-line element is hindered by the column element, but nevertheless manages to develop its effects in a reduced form.
0	The elements in the row and in the column are independent.
+1	The element in the row increases its effects thanks to the synergy created with the element in the column.
+2	The in-line element significantly increases its effects thanks to the synergy with the column element.

Fig. 6. Comparison of Dynamic SWOT.

service infrastructure but also seeks to create an intricate network of connections and relationships that reconnect a previously fragmented territory.

From the definition of objectives and linking them to the results obtained from the SWOT + STEEP analyses, it has been possible to identify the main criteria to consider during the definition of the multicriteria analysis, aimed at outlining possible project scenarios.

3.4 Scenario Building

Building upon the state of the art identified through the SWOT + STEEP analysis, along with the objectives defined in Sect. 3.3, various alternative definitions of future scenarios have been developed.

To fulfil the aims of the network objective, the scenario envisages the redevelopment of a brownfield site through the construction of multifunctional buildings. While, for what concerns the environment and connections objectives, the proposed alternatives, in accordance with the specifications of the tender, includes:

- A scenario with 100% of the construction required by the tender.
- A scenario with 60% of the construction.
- A scenario with 40% of the construction.

These options stem from the intention to develop a design capable of addressing gaps and meeting identified needs during the exploratory phase through the SWOT + STEEP analysis. A key element in determining scenarios was the amount of sealed soil, with implications for the sustainability and environmental quality of the area under consideration.

3.5 Analytic Hierarchy Process (AHP)

The first step involved constructing a hierarchy diagram to define the project's objective and correlate it with the three previously identified alternative scenarios.

A crucial phase in this process was the selection and identification of criteria and sub-criteria to assess the three established scenarios.

In order to have a comprehensive comparison of the risks that emerged from the SWOT + STEEP analysis from the perspective of environmental, economic and social sustainability, the criteria in Fig. 7 were identified, including those related to environmental health, comfort, profitability and social fabric.

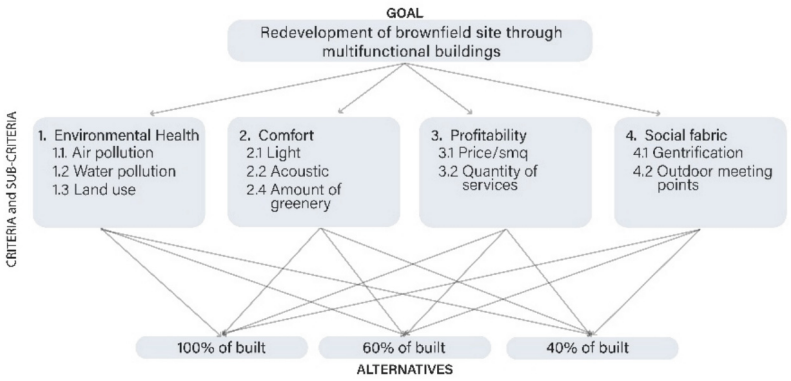


Fig. 7. Analytic Hiearchy Process (AHP) diagram.

After establishing the hierarchical structure, the subsequent process entailed pairwise comparisons using matrices. Firstly, all criteria were systematically compared with each other, followed by the comparison of subcriteria. Finally, each sub-criterion was compared in the AHP analysis within the context of the three land use alternatives of 40%, 60% and 100%. Subjective judgments were quantified using numerical ratings ranging from 1 to 9, assigned in ascending order of importance, as shown in Figs. 8 and 9. Throughout the comparative analyses, meticulous attention was dedicated to monitoring the level of inconsistency within the matrices, with a commitment to maintaining it below 10%.

ENVIRONMENTAL HEALTH is equally as important as COMFORT

ENVIRONMENTAL HEALTH	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	COMFORT

AIR POLLUTION is moderately more preferable than WATER POLLUTION

AIR POLLUTION	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	WATER POLLUTION

60% BUILT is very strongly to extremely more likely than 100% BUILT

60% BUILT	9	**8**	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	100% BUILT

Fig. 8. Example of pairwise comparison criteria, sub-criteria and alternatives.

After completing the analysis of pairwise comparison matrices, the optimal scenario has emerged, characterized by a preference for the option with a 60% construction rate, shown in Fig. 10. The definition of this scenario resulted from the weighted selection of evaluation criteria and sub-criteria, with particular attention to factors such as environmental health, comfort, and social cohesion. Additionally, economic implications related to the potential non-realization and funding of the intervention were taken into account. This decision aims to achieve a balanced compromise between environmental aspirations, comfort, and social justice, while simultaneously integrating the economic performance needs of the involved area.

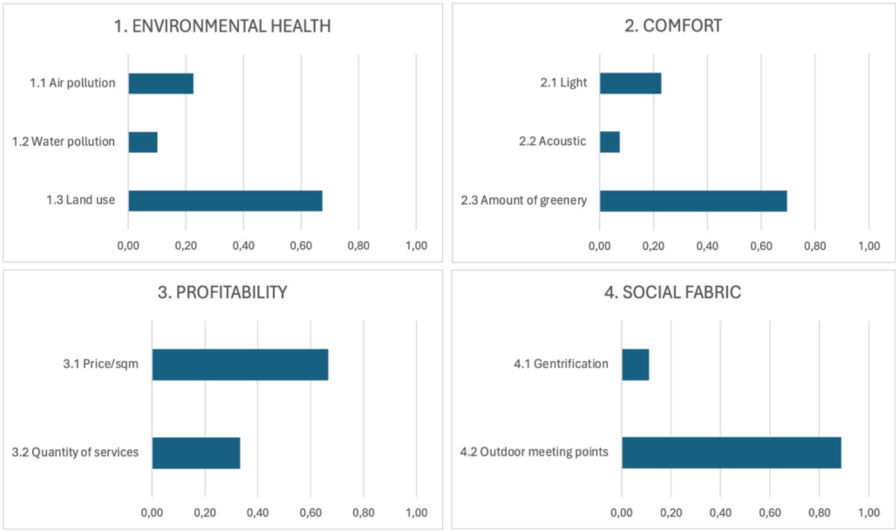


Fig. 9. Sub-criteria priority vectors.

4 Discussion

This paper investigates how a densification strategy for urban development can become more environmentally, socially, and economically sustainable through the support of the AHP analysis. The procedure relies on conventional assessment tools such as SWOT analysis and scenario building. It serves as an effective guide to orient the decision-making process towards sustainability in its various components.

The objective of the article is to highlight the intrinsic connection between infill development as a solution to urban sprawl, and its consequent soil sealing effects on the city. The Bobigny case study provides valuable insights into the importance of considering the urban densification process. Indeed, aspects such as ground coverage, building height, and their spatial arrangement emerge as crucial criteria for the success of smart growth approaches in reducing land occupancy and enhancing environmental quality, as well as soil permeability. The analysis does not delve into a detailed exploration of

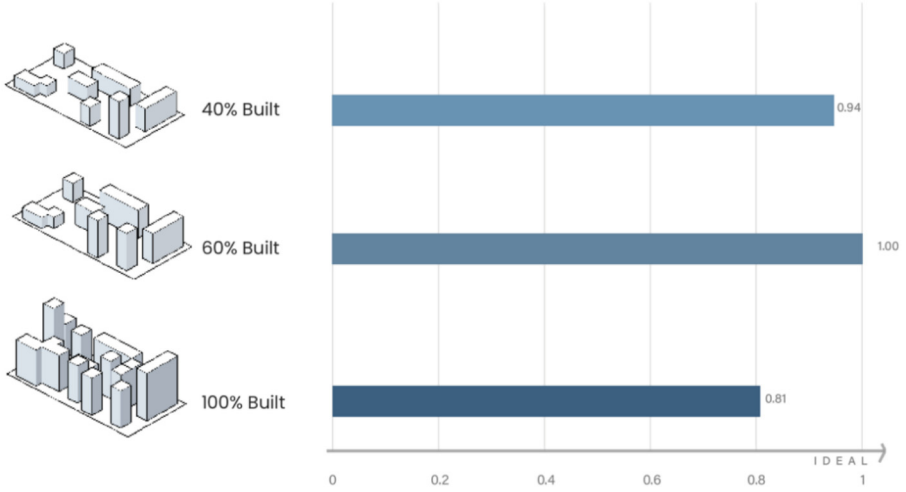


Fig. 10. Alternatives final ranking achieved for the case study.

building height and spatial arrangement, but rather focuses exclusively on determining a percentage of built area that copes with environmental and soil sustainability conditions.

In this paper, the building footprint is assumed to be 10 storeys equal for all constructions. Further analysis can be addressed to estimate the influence of an increasing number of storeys on the percentage of the built surface and its consequent implications on the environmental and comfort conditions. Moreover, spatial arrangement and site planning significantly influence the land occupancy. Yet these considerations were not addressed in the present study and may become the objective of further investigation once the percentage of soil occupancy derived from the current analysis is defined.

Furthermore, the sustainability of building construction also concerns construction methods, including materials used and construction techniques, factors not included in the analysis of the present study. It is crucial to ensure that the desired level of sustainability, established through the chosen soil percentage, is not compromised by factors such as the use of materials that contribute to an intensive pressure on the resources and the climate. The analysis primarily focused on the amount of occupied land and, as a result, criteria were established that address space at a total general level rather than specific details such as the selection of materials for building construction or materials that characterize ground pathways, which should be subject to more detailed analysis and investigation to ensure compliance with the concept of soil de-sealing addressed in the paper.

Finally, during the definition of criteria for the AHP analysis, it would have been useful to also consider how the space occupied by buildings and their use could influence the area's revitalization, considering the functions that would be integrated into the buildings and their long-term impact on the surrounding space. Evaluating the different building uses could have constituted additional sub-criteria, as different functions generate different economic profits.

5 Conclusions

This research highlights the importance of adopting a holistic and balanced approach in urban planning, which considers several interrelated factors. The proposed method, based on conventional evaluation tools such as SWOT analysis and Scenario Building, integrated with mixed approaches like Stakeholder Analysis, serves as an effective guide for sustainability-oriented decision-making processes. Through this methodology applied on Bobigny case study, it was possible to consider a wide range of criteria and weight them according to their relative importance, thus allowing an informed decision process. The analysis primarily focused on constructing and examining scenarios to understand which option could provide the best compromise between sustainability and profitability, with a primary consideration on land use. Information gathered during territory analyses, synthesized through a SWOT + STEEP approach, provided a robust foundation for the scenario building phase. During the analysis and evaluation phase, scenarios with varying degrees of land use were considered, relying on insights derived from the SWOT + STEEP analysis. In a maximal sustainability perspective, a scenario with reduced land occupancy would be preferred. However, the analysis underscored the importance of also incorporating profitability criteria into the AHP analysis to ensure economic feasibility and site redevelopment.

The strong correlation between the selected criteria is seen in the closeness of the results in the final ranking. Nevertheless, the analysis revealed that assigning too low of a percentage of built-up areas (i.e. 40%) could limit the opportunities for economic and social development in the area, while too high an allocation (i.e. 100%) could compromise the environmental quality, living comfort and social cohesion. In conclusion, based on these considerations, the scenario of 60% of built-up area emerged as the preferred option, striking a balance between environmental sustainability and economic profitability.

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