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The Economic Evaluation of Projects as a Structuring Discipline of Learning Processes to Support Decision-Making in Sustainable Urban Transformations

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ABSTRACT

This paper is based on the following research questions: i) In which way could the discipline Economic Evaluation of Projects contribute to conveying the sustainability concept in urban settings among master's degree students? What are the methods/techniques that can support decision processes of sustainable urban transformation? In response to the two research questions, the paper proposes a multi-methodological framework as a design tool for students (future professionals) aimed at representing the decision problem from a sustainable planning perspective. Through a Problem-Based Learning approach based on a case study, the proposed framework considers: SWOT Analysis, Stakeholder Analysis (SA), Multicriteria Analysis (MCDA), Cash Flow Analysis (CFA), and the application of the Neighborhood Sustainability Assessment Tools (NSATools). The multi-methodological framework has been applied to an experimental teaching case study as part of the Economic Evaluation of Projects module demonstrating its effectiveness in terms of sustainable spatial planning and structuring of the decision process from a multi-actor perspective. Future directions of the research are aimed at tackling two major limitations of the multi-methodological framework as the need to closely reflect a real decision process through an iterative framework and the sometimes hard interpretation of some elements of urban sustainability.

1. INTRODUCTION

"Decision is not an act but a process" [1]

The increasing consumption of natural and economic resources, together with the deep changes that cities are undergoing in social, economic, and environmental terms, have so far progressively developed the need to consider sustainability from a multidisciplinary and integrated perspective within urban and territorial transformations [2, 3].

Therefore, the choices put in place within sustainable urban transformations play a fundamental role in order to consider not only economic maximization but the integration of qualitative and quantitative aspects [1] in the most rational way. Indeed, as Tsoukiàs affirms [4], rationality cannot be defined in terms of an objective but rather of the process itself. This means that it is not simply important to arrive at the best operational decision, but it is essential to structure a transparent and inclusive decision-making process.

Making tangible the process towards urban sustainability is currently the paradigm of urban planning [5] wherein decision-making processes are innovating their approach by turning their attention to methods and techniques for defining strategic visions that can be implemented through the coherence of sustainable urban transformation processes. In view of this, it appears therefore necessary to identify sustainable and inclusive approaches, structuring decision-making processes aimed at finding a balance between different needs [4].

From this perspective, it is essential that the Universities of Architecture and Planning are able to provide students with methods/techniques to govern the crescent complexity of decision-making processes in order to propose sustainable urban transformation in the future. In this regard, the discipline Economic Evaluation of Projects (EEP) seems to have excellent potential being historically fundamental to the training of land use and planning professionals by dealing with theories and estimation procedures aimed at making judgments of economic and financial viability. The discipline also plays special attention to integrated environmental-economic-social analysis including the evaluation of the effects of programs/plans/projects according to monetary and multicriteria quanti-qualitative approaches in a logic of sustainable development.

To contribute to this debate, this paper is based on the following research questions:

i. In which way could the discipline "Economic Evaluation of Projects" (EEP) contribute to conveying the sustainability concept in urban settings among master's degree students?
ii. What are the methods/techniques that contribute to supporting the decision-making processes of sustainable urban transformation?

To give answer to the research questions, this paper proposes a multi-methodological framework [6, 7] based on quantitative and qualitative assessment methods as: Strength, Weakness, Opportunity and Threats (SWOT) Analysis [8], Stakeholder Analysis (SA) [9], Multicriteria Analysis (MCDA)

[10], Cash Flow Analysis (CFA) [11], and Neighborhood Sustainability Assessment Tools (NSATools) [12].

The development of this multi-methodological framework took place starting from a didactic module of EEP during which a number of master's degree students were asked to apply the proposed methods to a complex territorial case study in the perspective of the Problem-Based Learning approach (PBL) [13].

The neighborhood territorial scale is considered since it provides an intermediate spatial scale [14, 15] by covering a manageable portion of a territory while being scalable for larger and smaller areas [16].

After this introduction, the paper is structured as follows: section 2 gives an overview of the research method adopted; section 3 develops the different steps of the proposed multi-methodological framework; and finally, section 4 discusses the results and possible developments.

2. RESEARCH METHOD

The EEP module, from which the present research moves, was coordinated by the first author of the paper as part of the integrated course "Architecture and Urban Economics", which saw the involvement of different disciplines such as: design, sociology, economic evaluation of projects, and urban economics. The course was held at the Politecnico di Torino (Italy) within the framework of the master's degree in Architecture, Construction, City and was attended by 30 students.

The whole course was based on the PBL approach [13, 17-19], which consists of a teaching methodology based on a complex decision-making problem (defined as a case study) proposed at the beginning of the design path to the students, who are asked to find a solution. The complex decision-making problem is thus used to stimulate students' learning of concepts and principles as an alternative to the classic *ex cathedra* approach. As demonstrated by the scientific literature [18, 20], the PBL has several advantages: i) it stimulates self-learning by favoring the retention of knowledge over time; ii) it allows for greater integration between disciplines; iii) it supports students in identifying new, non-prepared solutions; iv) it improves the ability to search for information and tackle problems; v) it favors interaction among students and teachers.

In the field of urban transformation, these skills are fundamental for a professional (whether architect or planner) who will have to structure complex decision-making processes, characterized by multiple elements and subject to very sudden changes in terms of local and global scenarios.

Within the integrated course, the sustainable transformation of the La Villette neighborhood in Paris (France) was identified as a decision-making problem by the teachers, who subsequently illustrated it on the basis of their area of expertise to provide the students with a comprehensive knowledge base on the analysis area. Consequently, each student was then called upon to independently deepen the information previously provided through a detailed study of the area.

Accordingly, this first exploratory and cognitive phase allowed to lay the foundations for the application of the multi-methodological framework conducted inside the EEP module.

The multi-methodological framework includes six steps, each of which is conducted through a specific evaluation method. To reflect the dynamics of real decision-making processes, the students applied each step individually or in group, as declined in Figure 1.

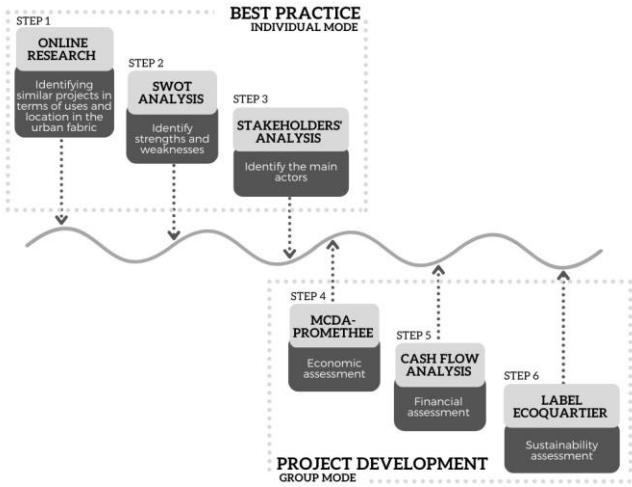

Figure 1. List of methods applied by students in the design unit

Figure 1 summarizes the multi-methodological framework proposed, showing the main objectives of each method used related to each step, as well as whether it can be carried out by students individually or in groups.

The first three Steps of the multi-methodological framework are provided in individual mode and involve the construction of an informative catalog from best practices case studies in the perspective of learning from the past.

In particular:

- Step 1 provides a desk search to explore and identify an urban transformation similar to the decision-making problem under consideration in terms of uses and places in the urban fabric and understand their dynamics;
- Step 2 involves the application of a SWOT analysis to highlight positive/negative elements of the urban transformation identified in Step 1 and to be better situated to anticipate possible problems for future development. SWOT aims at structuring the state of the art, considering endogenous factors (i.e., strengths and weaknesses), and envisioning the possible outcomes (i.e., opportunities and threats) [8];
- Step 3 develops SA for the urban transformation identified in Step 1. The analysis provides information about the stakeholders involved in a similar process as the one of their projects. This gives to the students the knowledge about the actors that need to be considered in the development of their projects [9];

It has to be pointed out that, the following three Steps of the multi-methodological framework are provided in group mode to replicate the dynamics of interaction and exchange expected from a real decision-making process. Differently from the previous steps, the last three steps are therefore aimed at the design definition of the urban area subject to transformation.

In particular:

- Step 4 provides for the application of MCDA that strategically aims at pursuing different objectives: i) considering the perspectives of the actors involved in the transformation; ii) exploring qualitative and quantitative elements of the transformation; iii) comparing different project alternatives and identifying

the best development project possible [21];
- Step 5 reveals the financial feasibility of the urban project through a CFA aimed at analyzing the costs and revenues [22];
- Step 6 involves the use of the NSATools to verify and certify the overall sustainability of the urban transformation proposed [3].

3. MULTI-METHODOLOGICAL FRAMEWORK

3.1 The case study

To properly illustrate the application of the multi-methodological framework described in section 2 within the EEP course, it is necessary to introduce the decision-making problem related to the sustainable transformation of the La Villette district in Paris (France) (Figure 2) which constitutes the basis of the PBL.

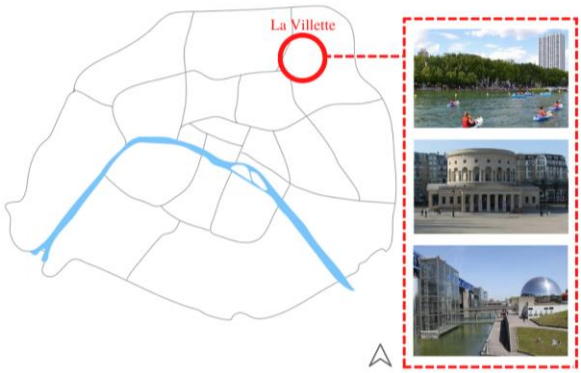

Figure 2. La Villette district in Paris

Figure 2 shows the La Villette district, located in the 19th arrondissement, in the north-eastern part of the capital, constituting the 73rd administrative district of Paris.

La Villette is part of a portion of territory that was fully annexed to Paris in the second half of the 19th century and has been characterized by complex urban changes due in part to the industrialization it has undergone. Moreover, the presence of the railway and the water bodies has shaped both the urban morphology and the organization of the La Villette district over time, raising issues about the design of urban transformations concerning the relationship between private and public spaces, as well as the use of collective space and the distribution of functions.

Accordingly, La Villette highlights specific peculiarities deriving from the structural elements of the river and the railway, which characterize its urban conformation while also articulating the intended uses of the land and the built environment distribution in terms of communication between public and private.

Considering the urban transformation perspective of the La Villette district, the students have been therefore required to structure a complex decision-making problem, characterized by multiple elements and subject to possible unforeseeable reconfigurations in terms of the local scenario.

3.2 Step 1: Best practice research

The master's students involved in the EEP module first worked individually on best practice case studies, not necessarily located in Paris, with the specific aim of studying scenarios based on similar functions, relationships between public and private spaces, or even the presence of both blue and grey infrastructures. This analysis provided a knowledge base in terms of possible strengths and weaknesses in the feasibility of the project to be developed.

This has been a fundamental stage in the PBL approach because it allowed the students to become aware of the possible dynamics of the area subjected to intervention, starting from the analysis of similar areas that have already been transformed and, consequently, of which the outcomes can be known. Moreover, this step allowed to highlight the stakeholders involved in creating a knowledge base that can be replicated in the transformation under study.

3.3 Step 2: SWOT analysis

After the identification of the best practices case studies, each student was asked to apply a SWOT analysis to analyze them in detail.

Originally developed in marketing and economic sectors [8], the SWOT Analysis is nowadays a common tool applied for structuring plans, programs, and projects. Specifically, the SWOT Analysis allows to frame the decision-making problem in a 4-quadrant matrix according to endogenous (strengths and weaknesses) and exogenous factors (opportunities and threats). In particular, Strengths (S) and Weaknesses (W) represent current features of the object under analysis able to respectively support or compromise the achievement of the objective; Opportunities (O) and Threats (T) are external conditions that could or could not happen in the future useful respectively to reach the goal or reduce its performance.

This representation clearly shows the current condition of the plan, program, or project under investigation, as well as the possible outcomes of its implementation. The SWOT Analysis is therefore a powerful tool in scenario planning since the first stages, empowering the main strengths and opportunities, solving weaknesses, and preventing threats [23, 24].

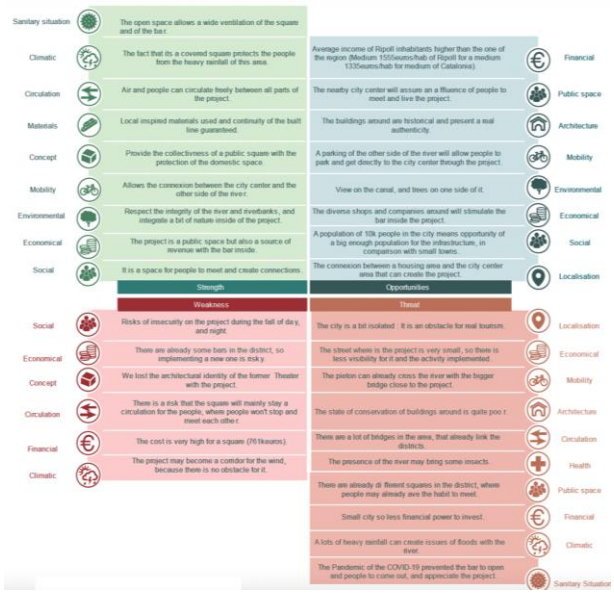

Figure 3. Example of SWOT Analysis of a best practice case study

Each student within the EEP module applied the SWOT Analysis to a specific existing project. The analysis of urban

transformations similar to the one under examination gave the students experience of the complexity of the processes and the knowledge to well develop their own urban projects in the La Villette district.

Figure 3 reports an example of SWOT analysis conducted by the master's degree students.

The development of the SWOT analysis helped the students focus on the main characteristics and future implications of a project. In particular, the students learnt by doing what is important and should be used for their project design, as well as the main criticalities that could be also part of their planning process. Based on the project features, the student has considered a set of aspects to structure the SWOT analysis, such as mobility, public space, health, circulation, materials, and localization. Then, the main fields of sustainable development and the sanitary situation of the COVID-19 pandemic are investigated in the SWOT analysis, to have a more comprehensive perspective on the project.

3.4 Step 3: Stakeholders Analysis (SA)

Starting from the results obtained from the application of the SWOT analysis, the students have been called to provide the analysis of the stakeholders involved in the transformation dynamics of the best practice case studies (identified in step 1).

Within the sustainability assessment procedures, the SA represents a useful approach able to highlight the conflicts among stakeholders since the beginning of the decision-making process and how to properly manage them [25].

In the SA, all the actors interested and engaged in the process are listed and analyzed to understand their influences on the decisional outcomes, their individual interests and objectives based on their values and preferences, and their views resulting from the interrelations with the other stakeholders [9]. This analysis is particularly useful in urban transformation projects since a single or a group of actors can strongly affect the final results [26].

The development of SA is aided by a variety of approaches. During the EEP module, 3 different approaches have been proposed to the students:

- the Power-Interest Matrix [27, 28], which divides the stakeholders into a four-quadrant matrix based on their power and interest;
- the Stakeholder Circle [29] uses concentric rings and patterns to differentiate each stakeholder. The radial depth represents the degree of the stakeholder to compromise the project, while the size of the wedge and its relative area reflect the stakeholders' influence;
- the Social Network Analysis (SNA) [30, 31] shows the stakeholder interactions and resource exchange. The size and shape of the network, as well as the coalitions and key participants in the decision-making context, may all be seen using this method.

First, the students started their analysis with the collection of all the relevant stakeholders involved in the best practices case studies investigated. In this phase, the stakeholders have been classified based on their scale of intervention (national, regional, or local), the type of actors they are (political, bureaucratic, special interest, general interest, or experts) and the resources they have mobilized (political, economic, legal, and cognitive) [9].

Second, among the three SA approaches presented, students selected the most suitable one to analyze and represent the case study under analysis. It is interesting to underline that some students decided not to adopt a specific approach but to apply interactively all the proposed approaches to have the most comprehensive picture possible of the best practices case study. Through the application of the Stakeholders Circle, for example, the students identified the stakeholders whose interactions have been clarified by the application of the SNA. Then, the Power-Interest Matrix highlighted the resources, powers, and interests of the stakeholders based on possible outcomes of stakeholders' actions (Figure 4).

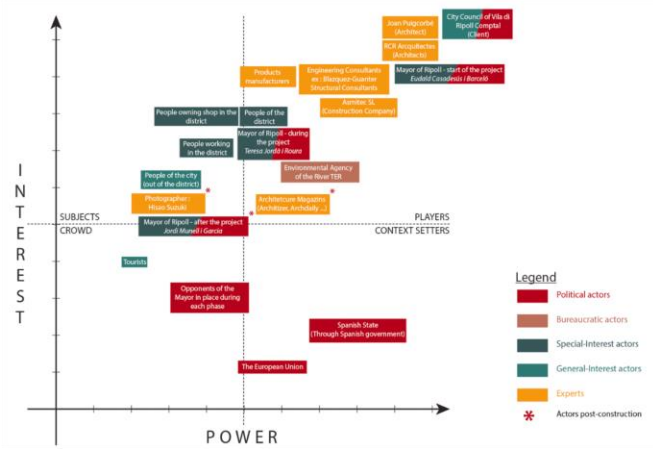

Figure 4. Example of Stakeholders Analysis

3.5 Step 4: Multicriteria Decision Analysis (MCDA)

After the SWOT and the SA, the students finally became aware of the different and conflicting aspects characterized by a new development project in the built environment. They became consciousness about the key stakeholders, understanding that their projects could not optimally solve all the dimensions of the problem (e.g., social, economic, and environmental perspectives), but they can propose scenarios able to perform the best possible.

At this point, the students started to work in groups (3 or 4 components each) to define project solutions for the area of La Villette. To support this design process, the groups applied MCDA to evaluate the ongoing projects and determine if something could be done for their amelioration. The adoption of MCDA has been chosen not simply for an *ex-post* evaluation of the scenarios, but to support students in building sustainable projects, able to consider the multi-dimensionality of built environment solutions. Specifically, to each group, it was assigned the scenarios of other groups to be assessed and compared. The final aim is to provide the other groups with some suggestions on how they can improve their projects, as well as to learn from the scenarios evaluated.

Among the different MCDA methodologies, the students applied the Preference Ranking Organization Method for Enriched Evaluation (PROMETHEE) (for a complete review of all MCDA methodologies, see [10]). PROMETHEE is an outranking method (OM), introduced by Brans et al. in 1982 [32] and implemented with Vincke [33]. It is applied in decision-making problems to evaluate a finite number of alternatives A={a, b, . . . , m}, according to a finite set of criteria G={g1, g2, . . . , gk}, often conflicting [34]. In OMs, the preference relation is an outranking relation among the alternatives based on the different criteria considered [35]. This means that the alternatives are compared in pairs to

express this outranking relation. Therefore, the alternatives have to be compared with all pairs of alternatives considered in the evaluation, through a binary relation [36].

The application of PROMETHEE follows 5 different stages [37]:

i. Stage 1 is the filling of the impact matrix: a double-entry table that links the alternatives with the evaluation criteria;

ii. Stage 2 is the establishment of the preference function $P(a,b)$ for each criterion: the preference function $P(a,b)$ varies between 0 to 1 and indicates how much the alternative a is preferred over the alternative b (i.e. value 1 means that there is a strict preference of an alternative over another alternative, while the value 0 means that the DM is indifferent between the two alternatives). To define the preference function, PROMETHEE uses 6 different preference functions (i.e., the usual, the u-shape, the V-shape, the level, the linear, and the gaussian);

iii. Stage 3 is the calculation of the overall preference index $\prod(a,b)$ (Eq. (1)):

$$\Pi(a,b) = \sum_{j=1}^{k} wjPj(a,b)$$

iv. This index represents the intensity of preference a over b, calculated as the sum of the preference functions of a over b for all criteria considered in the evaluation (j), multiplied with the weight of each criterion j;

v. Stage 4 is the calculation of the outranking flows: leaving flow Φ+(a) (how much an alternative is preferred over the other alternatives) and Φ-(a) (how much an alternative is overcome by the other alternatives);

vi. Stage 5 is the comparison of the outranking flows (Φ) to define the complete ranking of the alternatives.

The first stage of the process provides the identification of a set of criteria able to measure the different projects to be evaluated. Table 1 shows an exemplary list of criteria defined by a group of students. The list of criteria is based on the characteristics of the area of La Villette district, the projects, and their scale of analysis as well as the main stakeholders involved in the decision-making process, which have also been interpreted by each student of the group in the definition of the preference functions and the set of weights.

Then, each group of students filled the impact matrix with the different performances of the alternatives of the other groups for all the criteria (Table 2).

Based on the criteria performances (stage 1) of the scenarios analyzed, a balanced preference function among the stakeholders was established by the group for each criterion (stage 2) (Figure 5).

After this step, each component of the group continued to interpret the stakeholder to identify the priorities in the list of criteria selected (Table 3), using the Simos, Figueira, Roy (SRF) weighting method [38]. The SRF procedure was executed by the students through the free online software DecSpace (DecSpace, http://app.decspacedev.sysresearch.org/#/ (last access: 02/11/2021)).

Table 1. Example of the set of criteria for PROMETHEE evaluation

Cluster	Criteria	Description	Unit	Benefit(B)/ Cost (C)
Environmental	New green spaces	Creation of green areas, considering all areas in open air with grass or flower bed	Surface m^{-2}	B
Social	Collective spaces	Spaces dedicated to a collective use with or without green vegetation	Percentage over the total area %	B
Social	Accessibility for disabled people	Spaces that can be accessed (both physically and functionally) by all the types of disabled people	Percentage over the total area %	B
Social	Housing typology	Different housing typologies according to the different uses of the building	Qualitative scale (1-5)	B
Social	Housing area	Quantity of space dedicated to housing in the project	Surface m^{-2}	B
Economic	Job opportunities	Evaluation of new job opportunities made available in the project	Quantitative (FTF – Full time equivalent employee)	B
Economic	Commercial activities	Quantity of commercial activities in the project	Surface m^{-2}	B

Table 2. Example of impact matrix

Alternatives	Project 1	Project 2
New green spaces	536.4 m^{-2}	236.7 m^{-2}
Surface of collective spaces	43.1%	71.0%
Accessibility for disabled people	100%	87.8 %
Housing typologies	2	3
Housing area	385.9 m^{-2}	600 m^{-2}
Job opportunities	28	24
Commercial activities	250 m^{-2}	270 m^{-2}

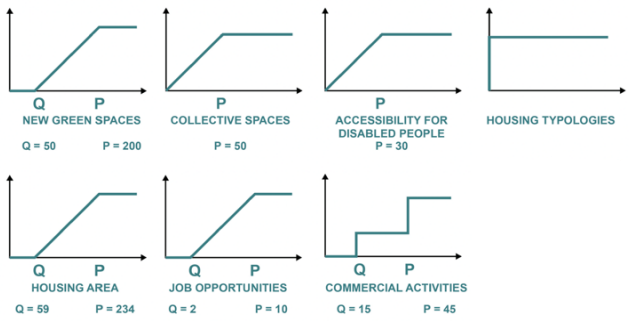

Figure 5. Example of preference functions for each criterion considered

Table 3. Example of Stakeholders' weights procedure with SRF method

	Code	Criteria	Normalized Weight
Public Administration	C1	Job opportunities	25.4
	C2	Commercial activities	22.4
	B2	Accessed for disabled people	17.4
	B1	Collective spaces	14.9
	B4	Housing area	10.4
	A1	New green spaces	7.4
	B3	Housing typologies	1.5
Communities	B1	Collective spaces	26.2
	C2	Commercial activities	23.2
	C1	Job opportunities	20
	A1	New green spaces	15.4
	B2	Accessed for disabled people	9.2
	B4	Housing area	4.6
	B3	Housing typologies	1.5
Promoter	B4	Housing area	26.7
	C2	Commercial activities	25
	B3	Housing typologies	18.3
	A1	New green spaces	13.3
	B1	Collective spaces	10
	B2	Accessed for disabled people	5
	C1	Job opportunities	1.7

For the automatic calculation of the overall preference index (stage 3), considering the weights assigned in the previous step and the outranking flows (respectively, stage 4 and stage 5), the students adopt the free downloadable software called Visual PROMETHEE (PROMETHEE Methods, http://en.promethee-gaia.net/ (last access: 02/11/2021)). The result of the evaluation conducted is reported in Figure 6.

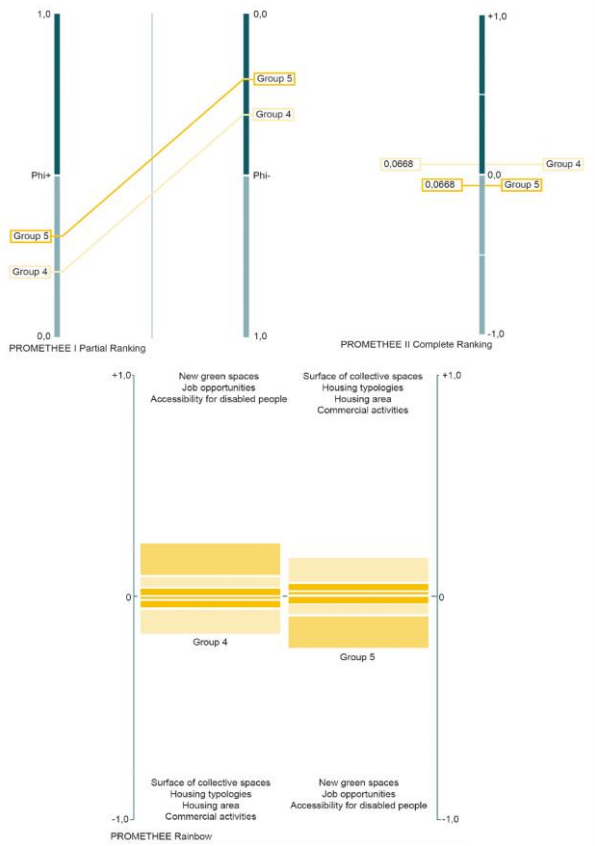

Figure 6. Example of final ranking (partial and complete outranking flows and rainbow diagram)

It is important to underline that, among the numerous MCDA available, the PROMETHEE was chosen to be used inside the EEP module for different reasons, namely:

i) to teach students the importance of satisfying stakeholders' preferences. The ability of PROMETHEE to involve stakeholders in various phases of the evaluation procedures allows the analyst to incorporate stakeholders' preferences and objectives in a more structured and clear way;

ii) PROMETHEE provides a final ranking of the alternatives, but also gives information about the coalitions among stakeholders and their preferences according to the alternatives proposed;

iii) PROMETHEE taught students about the importance of performance differences among the alternatives. This made them aware of the importance of each component that defines their project.

At the end of step 4, students were able to propose reasoned and shared urban transformation projects that were the result of in-depth analysis and peer comparisons.

By way of example, Figure 7 shows an urban transformation project within the La Villette district, whose main objective was to create a cohesive community in the neighborhood by improving the area from both a social and economic point of view, introducing new retail spaces and common areas alongside the original educational and leisure functions for the university community, as well as new types of housing.

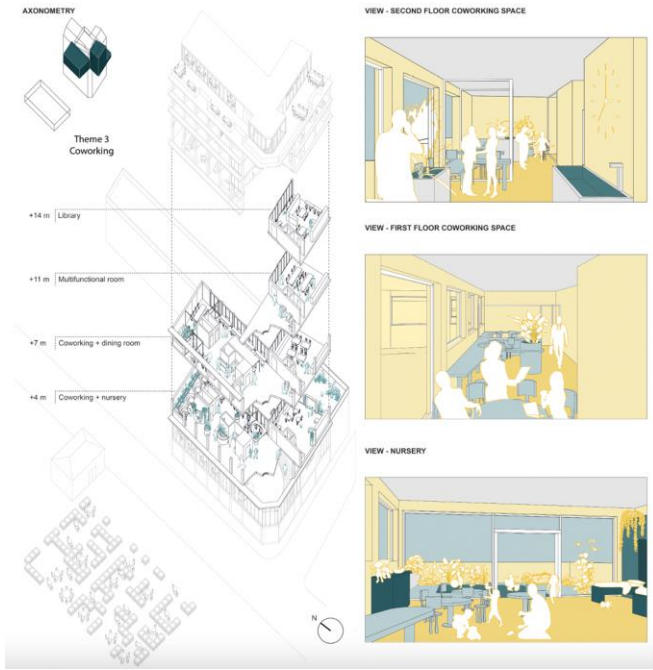

Figure 7. Example of the project considered within the urban transformation within the La Villette case study

3.6 Step 5: Cash Flow Analysis (CFA)

After comparing the alternative scenarios, step 5 of the multi-methodological framework includes the assessment of the financial feasibility through the application of CFA. CFA enables the development of the economic and financial performance criteria for investment projects [22, 39]. In this sense, CFA analyses the investment from the entrepreneur's point of view [40] and only considers monetary values, thus not considering the social or environmental effect of the project [41, 42]. The analysis reports all the costs and revenues

received from the project's implementation [43], in order to give stakeholders a complete picture of the financial sustainability of the operation according to the objectives and to maximize the monetary income from the investment [1].

The application of the CFA within the EEP module focused on the issue of land development, thus implying land acquisition with the intention of building public services and surface improvements, and reselling or renting some or all of the realizations, considering potential buyers or tenants, respectively. In particular, each group performs the following phases: the assessment of the costs and revenues, and the calculation of the Net Value.

The first step to be developed for the purpose of CFA is the definition and calculation of the costs of the project (Figure 8).

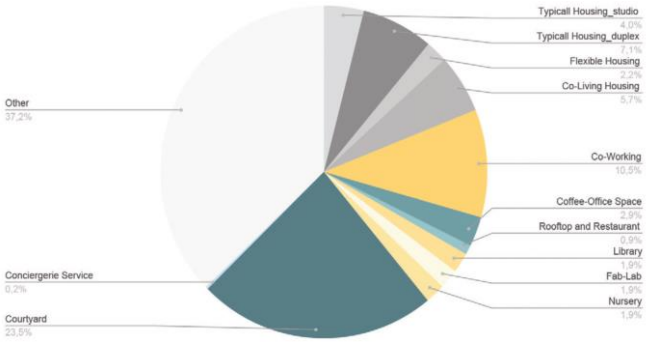

Figure 8. Example of costs distribution for all parts of the project considered

Figure 8 shows an example of the distribution of the costs within the project, applied to the case study of La Villette. For the estimation of the construction costs (Figure 9), the construction costs in €/m2 of net floor area before Value-Added Tax (VAT) are set annually by the French Ministry for Sustainable Development (Ministère de la Transition écologique, https://www.ecologie.gouv.fr/economie-construction#scroll-nav__3 (last access: 08/11/2021)) according to the variation of the Construction Cost Index (ICC).

After the definition and the calculation of the costs, the next step involved the definition and the calculation of the revenues of the project (Figure 9).

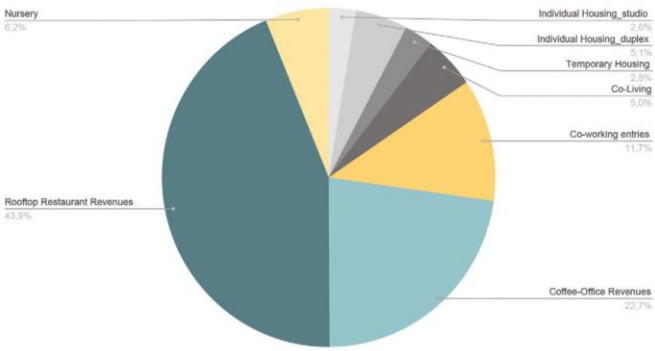

Figure 9. Example of revenues distribution for all parts of the project considered

Figure 9 shows an example of the distribution of the revenues. The revenues related to the rental option have been estimated using a direct estimation approach [44] assuming that the market value of the asset to be appraised is equal to the price of similar assets with similar characteristics, using as sources real estate agencies and analyses provided by specific companies reporting average representative data and real estate market quotations for the segments covered by the project (Figure 9).

Once the revenues of the project were identified and calculated, the next step involves the identification and connection of the activities generating the expenses and their related revenues (Figure 10).

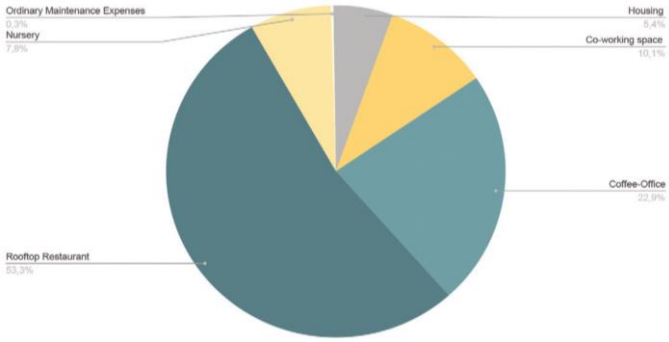

Figure 10. Example of monthly expenses of the project considered (associated with the revenues)

Moreover, the last step of the CFA application refers to the calculation of the Net Value as the difference between total revenues and total costs identified (Figure 11).

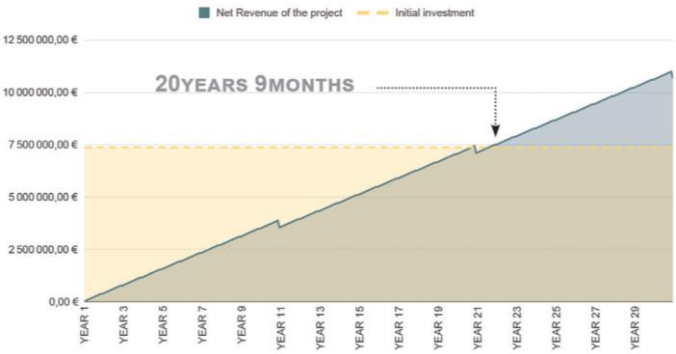

Figure 11. Cumulation of Net revenue on the project considered

From Figure 10 and Figure 11, it can be noted that the initial costs of the operation will be financially sustainable, reflecting the creation of different sources of revenues defined by the rent within the same project, considering also the expenses associated with the revenues (Figure 10). Moreover, Figure 10 shows the increasing expectation of the cumulation of net income on the project against the initial investment.

The application of CFA within the project allowed the students to analyze the actual balance between cash outflows and inflows at the end of its realization. This makes the students more aware of the urban transformation process and the possible uncertainties to be managed. These uncertainties could influence the timing of realization as well as the amounts of inflows and outflows [43, 45].

Moreover, the application of CFA appears fundamental within the multi-methodological framework from an integrated sustainability perspective within the entire design process, since it considers not only the environmental

sustainability component, but also the economic and financial feasibility of the urban transformation project.

3.7 Step 6: Neighborhood sustainability assessment tool

The last step of the multi-methodological framework includes an in-depth analysis on the feasibility of the urban projects in terms of overall sustainable development through the adoption of the NSATools. The NSATools are voluntary assessment tools that aim to spread the culture of sustainable construction and planning by implementing a rating system to assess the environmental impact of the construction sector [3], [46]. These rating tools were conceived in the 1990s to achieve optimal performance with reference to the energy consumption and production of single buildings [47]. However, the integration of the concept of sustainable development in its broader conception within the framework of not only energy consumption but also social, economic, and institutional issues [3], progressively underlined the inadequacy of the single building scale, making necessary the development of the NSATool at a broader scale to better capture the multidimensionality of sustainability [48, 49]. In terms of assessment structure, the different NSATools show a similar configuration articulated through a hierarchical model conceptually comprising macro-themes, deepened by criteria, and assessed through indicators (quantitative or qualitative), which therefore constitute the first step of the evaluation model [47].

The purpose of analyzing sustainability through the NSATool, within the multi-methodological framework proposed, is not to find an application considering the entire assessment process of this tool, but rather to gain awareness in general terms of which elements of sustainability must be considered within an urban transformation. Considering the case study of the La Villette district (France), inside the EEP module, it was decided to focus on the application of the French Label EcoQuartier NSATool, mostly used in France, including about 2000 certified projects in Paris.

Moreover, the Label EcoQuartier has the peculiarity of being promoted at a governmental level and not by private organizations like other NSATools. Additionally, it also supports an *ex-post* evaluation, making therefore the evaluation integral within the whole transformation process [50] according to an integrated perspective of sustainability assessment.

The assessment model of the Label EcoQuartier includes 4 Dimensions referring to the thematic areas investigated within this tool. Every Dimension includes 5 Engagements, which are the principles declining the Dimensions and which include 1 to 3 Notions per each, which represent the criteria containing the indicators (quantitative or qualitative) where the evaluation starts [50] (Figure 12).

The 4 Dimensions of the assessment structure of the Label EcoQuartier shown in Figure 12 include different thematic areas relevant to the sustainability assessment of the overall project. In particular, the first Dimension refers to the support of the collective participation of local citizens within the decision-making process; the second Dimension is related to the preservation of heritage and the realization of a quality project, also in social terms; the third Dimension considers aspects related to the sustainable development of the neighborhood, including short-range policies and production chains; the fourth Dimension refers to the environmental sphere and the reduction of negative externalities on the environment produced by the buildings and the project as a whole.

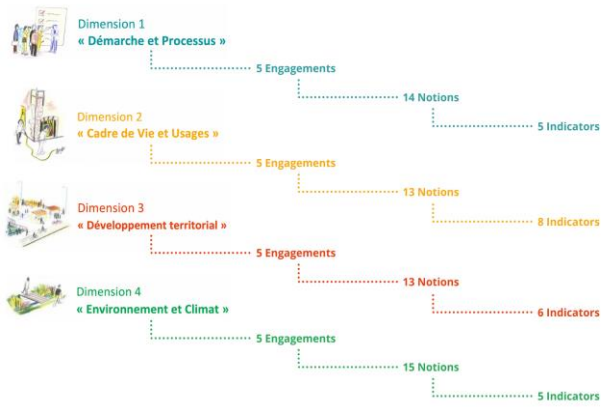

Figure 12. The Label EcoQuartier assessment structure

It should be emphasized that a simplified version of the Label EcoQuartier has been applied within the EEP module relating to the case study of the La Villette district, considering reasons of time with respect to the complex multi-methodological framework comprising many steps and evaluation methodologies that the students were required to apply. To shorten the timing of the evaluation, the simplified version of the application of the Label EcoQuartier did not include the detailed measurement of the indicators (Figure 12) but a qualitative assessment that each group of students conducted with respect to the projects by expressing for each Notion a degree of achievement on a 5-point Likert scale (where 0 corresponds to non-achievement and 5 to complete achievement) [51]. The scores of the Notions were subsequently summed up to reach the score of each Dimension, which in turn was summed up according to the Dimension's weight given within the Label EcoQuartier (25% for each Dimension) to give the overall sustainability score of the project (Figure 13).

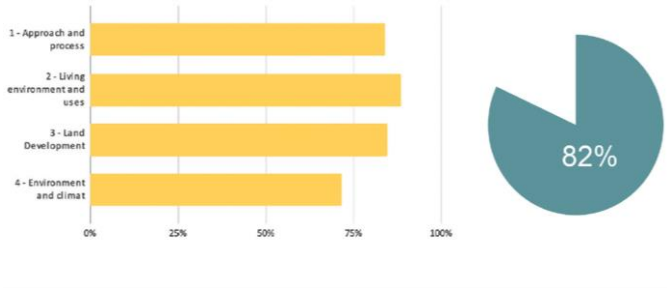

Figure 13. Example of percentage of completion of each Dimension of the Label EcoQuartier and the overall sustainability of the project

Figure 13 shows an example of a high level of sustainability within the project, which in fact acceptably fulfills all the Dimensions considered within the Label EcoQuartier, entailing considerable savings in energy consumption by considering green roofs and green areas inside the blocks.

Accordingly, Figure 14 shows how the modular spaces foreseen by the project can also be used by associations, and the diversification of the types of housing lend themselves to stimulating the social and associative life of the neighborhood on the one hand and bringing users into the project on the other.

Finally, an efficient and flexible economic model is expected to be created thanks to the spaces planned for long-term or temporary workers, as well as those dedicated to self-fabrication and small-scale industrial processes.

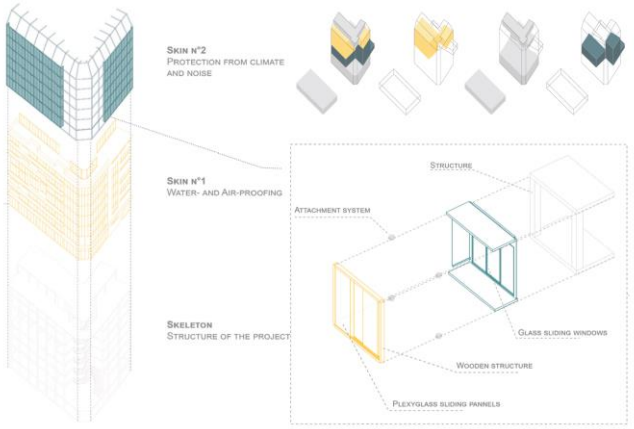

Figure 14. Example of the project considered within the urban transformation of the La Villette case study

Despite the simplifications made by applying a qualitative assessment of the Label EcoQuartier, this last step of the multi-methodological framework appeared fundamental, since it returned an integrated assessment of the sustainability of the project, considering all the different useful elements to the pursuit of the overall sustainability of an urban transformation project [47].

4. CONCLUSIONS AND FUTURE DEVELOPMENTS

The structuring and application of a multi-methodological framework for assessing sustainability related to the teaching experience reported in this article contributes to the current debate on the realization of sustainable urban projects and how this culture can be transferred within the Universities of Architecture and Planning.

Firstly, this experience shows how “economic evaluations of projects” can play a key role not only in defining the financial aspects of an urban transformation but also in the structured organization of the decision-making process. Indeed, the “economic evaluation of projects” can teach students (future professionals) to collect and organize information of different natures to properly orient urban project choices. This is particularly true if this discipline adopts the PBL approach, alternating individual, and group work. In fact, it has been demonstrated how this type of didactic approach can have considerable potential in solving a problem, allowing students to internalize methods and increase awareness of the different dimensions that contribute to an urban project.

Secondly, the proposed multi-methodological framework stands as a design tool that demonstrates significant advantages from the development of an integrated perspective involving different aspects of the qualitative and quantitative problems in a multi-disciplinary context. Indeed, the selection of methods/techniques within the framework is the result of a trans- and multi-disciplinary reasoning. First, through the application of the SWOT and SA to the analysis of best practice case studies similar to the problem to be addressed, it is possible to create the knowledge base necessary for the development of a project by anticipating possible problems and dynamics. Second, the MCDA allows qualitative and quantitative elements to be considered, thus orienting the urban project in a conscious and sustainable manner. Third, the CFA allows the investment to be analyzed through economic and financial return criteria for the project. Finally, the NSATool can be an important tool for evaluating urban sustainability, assessing the performance of projects that can be modified to obtain better scores.

This kind of integrated assessment must start from the early stages of the decision process to the identification of the most sustainable scenario, considering at the same time the context specificities, the stakeholders engaged, and the conflicting aspects that characterize an urban transformation.

Despite the success of the didactic innovation experimentation, it is worth highlighting some limitations of the proposed multi-methodological framework: i) the NSATool applied in this experimentation (Label EcoQuartier) is qualitative in nature and has a national outlook, leaving room for interpretation of the elements of sustainability; ii) the students found a general difficulty in the sequential application of the analyses provided by the multi-methodological framework.

Starting from these limitations, which risk misdirecting the design project, future developments of the work will consider the inclusion in the multi-methodological framework of an NSATool of an international and quantitative nature (Breeam [52] or Leed [53]) in order to better intercept all dimensions of sustainability as objectively as possible. In addition, the multi-methodological framework will be structured for its iterative application during the design process so as to better reflect the dynamics of a decision process.

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REFERENCES

[1] Simon, H.A. (1976). Administrative Behavior. A Study of Decision-Making Processes in Administrative Organization. Free Press, New York.

[2] Abastante, F., Lami, I.M. (2016). An integrated assessment framework for the requalification of districts facing urban and social decline. In: Seminar of the Italian Society of Property Evaluation and Investment Decision, Springer, Cham, 535-545. https://doi.org/10.1007/978-3-319-78271-3_42

[3] Abastante, F., Lami, I.M., Gaballo, M. (2021). Pursuing the SDG11 targets: The role of the sustainability protocols. Sustainability, 13(7): 3858. https://doi.org/10.3390/su13073858

[4] Tsoukiàs, A. (2007). On the concept of decision aiding process: An operational perspective. Annals of Operations Research, 154(1): 3-27. https://doi.org/10.1007/s10479-007-0187-z

[5] Kaur, H., Garg, P. (2019). Urban sustainability assessment tools: A review. Journal of Cleaner Production, 210: 146-158.

https://doi.org/10.1016/j.jclepro.2018.11.009
[6] Creswell, J.W., Plano Clark V.L. (2011). Designing and Conducting Mixed Methods Research. Sage, Thousand Oaks, California, USA.
[7] Oliveira, M., Miguel, M., van Langen, S.K., Ncube, A., Zucaro, A., Fiorentino, G., Passaro, R., Santagata, R., Coleman, N., Lowe, B.H., Ulgiati, S., Genovese, A. (2021). Circular economy and the transition to a sustainable society: Integrated assessment methods for a new paradigm. Circular Economy and Sustainability, 1: 99-113. https://doi.org/10.1007/s43615-021-00019-y
[8] Humphrey, A.S. (2005). SWOT Analysis for Management Consulting. SRI Alumni Newsletter. SRI International, United States.
[9] Dente, B. (2014). Understanding Policy Decisions. In: SpringerBriefs in Applied Sciences and Technology, Springer International Publishing, Cham, 1-27. https://doi.org/10.1007/978-3-319-02520-9_1
[10] Greco, S., Figueira, J., Ehrgott, M. (2016). Multiple Criteria Decision Analysis (Vol. 37). Springer, New York. https://doi.org/10.1007/978-1-4939-3094-4
[11] Navon, R. (1997). Cash-flow Forecasting and Management. Proc., Construction Congress, ASCE, New York, 1056-1063.
[12] Sala, S., Ciuffo, B., Nijkamp, P. (2015). A systemic framework for sustainability assessment. Ecological Economics, 119: 314-325. https://doi.org/10.1016/j.ecolecon.2015.09.015
[13] Sivan, A., Leung, R.W., Woon, C., Kember, D. (2000). An implementation of active learning and its effect on the quality of student learning. Innovations in Education and Training International, 37(4): 381-389. https://doi.org/10.1080/135580000750052991
[14] Abastante, F., Lami, I.M., La Riccia, L., Gaballo, M. (2020). Supporting resilient urban planning through walkability assessment. Sustainability, 12(19): 8131. https://doi.org/10.3390/su12198131
[15] Caprioli, C., Bottero, M., Pellegrini, M. (2019). An Agent-Based Model (ABM) for the evaluation of energy redevelopment interventions at district scale: An application for the San Salvario neighborhood in Turin (Italy). In: International Conference on Computational Science and Its Applications, pp. 388-403. Springer, Cham. https://doi.org/10.1007/978-3-030-24302-9_28
[16] La Riccia, L., Cittadino, A., Fiermonte, F., Garnero, G., Guerreschi, P., Vico, F. (2019). The walkability of the cities: Improving it through the reuse of available data and raster analyses. In: Spatial Planning in the Big Data Revolution; Voghera, A., La Riccia, L. (eds) IGI Global, 113-137 Hershey, Pennsylvania, USA. https://doi.org/10.4018/978-1-7998-7297-9.ch017
[17] Moust, J., Bouhuijs, P., Schmidt, H. (2021). Introduction to Problem-Based Learning: A Guide for Students. Routledge. https://doi.org/10.4324/9781003194187
[18] Koschmann, T.D., Feltovich, P.J., Myers, A.C., Barrows, H.S. (1992). Implications of CSCL for problem-based learning. ACM SIGCUE Outlook, 21(3): 32-35.
[19] Wood, D.F. (2003). Problem based learning. BMJ, 326: 328-330. https://doi.org/10.1136/bmj.326.7384.328
[20] Hmelo-Silver, C.E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3): 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3
[21] Dodgson, J.S., Spackman, M., Pearman, A., Phillips, L.D. (2009). Multi-criteria analysis: A manual. Department for Communities and Local Government. London.
[22] Park, H.K., Han, S.H., Russell, J.S. (2005). Cash flow forecasting model for general contractors using moving weights of cost categories. Journal of Management in Engineering, 21(4): 164-172. https://doi.org/10.1061/(ASCE)0742-597X(2005)21:4(164)
[23] Bottero, M., Assumma, V., Caprioli, C., Dell'Ovo, M. (2021). Decision making in urban development: The application of a hybrid evaluation method for a critical area in the city of Turin (Italy). Sustainable Cities and Society, 72: 103028. https://doi.org/10.1016/j.scs.2021.103028
[24] Treves, A., Bottero, M., Caprioli, C., Comino, E. (2020). The reintroduction of Castor fiber in Piedmont (Italy): An integrated SWOT-spatial multicriteria based approach for the analysis of suitability scenarios. Ecological Indicators, 118: 106748. https://doi.org/10.1016/j.ecolind.2020.106748
[25] Gill, L., Lange, E., Morgan, E., Romano, D. (2013). An analysis of usage of different types of visualisation media within a collaborative planning workshop environment. Environment and Planning B: Planning and Design, 40(4): 742-754. https://doi.org/10.1068/b38049
[26] Caprioli, C., Bottero, M. (2020). Addressing complex challenges in transformations and planning: A fuzzy spatial multicriteria analysis for identifying suitable locations for urban infrastructures. Land Use Policy, 102: 105147. https://doi.org/10.1016/j.landusepol.2020.105147
[27] Johnson, G., Scholes, K., Whittington, R. (1999). Corporate strategy. Europe, London Prentice Hall.
[28] Mendelow, A. L. (1981). Environmental scanning: the impact of stakeholder concept. In: Proceedings of the Second International Conference on Information Systems. Cambridge, Mass.
[29] Bourne, L., Kasperczyk, S. (2009). Introducing a stakeholder management methodology into the EU. Paper presented at PMI® Global Congress 2009—EMEA, Amsterdam, North Holland, The Netherlands. Newtown Square, PA: Project Management Institute.
[30] Marin, B., Mayntz, R. (1991). Policy networks: Empirical evidence and theoretical considerations. Frankfurt a. M.: Campus Verlag.
[31] Rhodes, R.A. (1997). Understanding governance: Policy networks, governance, reflexivity, and accountability. Open University.
[32] Brans, J. P., Vincke, P. (1985). A preference ranking organisation method: (The PROMETHEE method for multiple criteria decision-making). Management Science, 31(6): 647-656. https://doi.org/10.1287/mnsc.31.6.647
[33] Brans, J., Vincke, P. (1985). A preference ranking organization method: The PROMETHEE method for MCDM. Management Science, 31(6): 647-656.
[34] Bouyssou, D. (1990). Building criteria: A prerequisite for MCDA. In: Readings in Multiple Criteria Decision Aid (pp. 58-80). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-75935-2_4
[35] Brans, J.P., Vincke, P., Mareschal, B. (1986). How to select and how to rank projects: The Promethee method. European Journal of Operational Research, 24(2): 228-

238. https://doi.org/10.1016/0377-2217(86)90044-5
[36] Bottero, M., D'Alpaos, C., Oppio, A. (2018). Multicriteria evaluation of urban regeneration processes: An application of PROMETHEE method in Northern Italy. Advances in Operations Research, 1-12. https://doi.org/10.1155/2018/9276075
[37] Brans, J.P., Mareschal, B. (1995). The PROMETHEE VI procedure: How to differentiate hard from soft multicriteria problems. Journal of Decision Systems, 4(3): 213-223. https://doi.org/10.1080/12460125.1995.10511652
[38] Figueira, J., Roy, B. (2002). Determining the weights of criteria in the ELECTRE type methods with a revised Simos' procedure. European Journal of Operational Research, 139(2): 317-326. https://doi.org/10.1016/S0377-2217(01)00370-8
[39] Shash, A.A., Qarra, A.A. (2018). Cash flow management of construction projects in Saudi Arabia. Project Management Journal, 49(5): 48-63. https://doi.org/10.1177/8756972818787976
[40] Maravas, A., Pantouvakis, J.P. (2012). Project cash flow analysis in the presence of uncertainty in activity duration and cost. International Journal of Project Management, 30(3): 374-384. https://doi.org/10.1016/j.ijproman.2011.08.005
[41] Lami, I. M. (2020). Shapes, Rules and Value. In: Abandoned Buildings in Contemporary Cities: Smart Conditions for Actions, pp. 149-162. Springer, Cham. https://doi.org/10.1007/978-3-030-35550-0
[42] Lami, I.M., Mecca, B. (2021). Architectural project appraisal: An active learning process. Valori e Valutazioni, 28. https://doi.org/10.48264/VVSIEV-20212802
[43] Mirnezami, S.A., Mousavi, S.M., Antuchevičienė, J., Mohagheghi, V. (2020). A new approach for multi-scenario project cash flow analysis based on todim and critical chain methods under grey uncertainty. Economic Computation and Economic Cybernetics Studies and Research, 54(2): 263-279. https://doi.org/10.24818/18423264/54.2.20.16
[44] Devine, A., Yönder, E. (2021). Impact of environmental investments on corporate financial performance: Decomposing valuation and cash flow effects. The Journal of Real Estate Finance and Economics, 1-28. https://doi.org/10.1007/s11146-021-09872-y
[45] Dorfeshan, Y., Mousavi, S.M. (2019). A group TOPSIS-COPRAS methodology with Pythagorean fuzzy sets considering weights of experts for project critical path problem. Journal of Intelligent and Fuzzy Systems, 36(2): 1375-1387. https://doi.org/10.3233/JIFS-172252
[46] Lami, I.M., Abastante, F., Gaballo, M. (2021). Supporting the transition from linear to circular economy through the sustainability protocols. In: International Conference on Computational Science and Its Applications, Springer, Cham, 626-641. https://doi.org/10.1007/978-3-030-87007-2_45
[47] Dí az-Lṕez, C., Carpio, M., Martín-Morales, M., Zamorano, M. (2019). Analysis of the scientific evolution of sustainable building assessment methods. Sustainable Cities and Society, 49: 101610. https://doi.org/10.1016/j.scs.2019.101610
[48] Haapio, A., Viitaniemi, P. (2008). A critical review of building environmental assessment tools. Environmental Impact Assessment Review, 28(7): 469-482. https://doi.org/10.1016/j.eiar.2008.01.002
[49] Berardi, U. (2013). Sustainability assessment of urban communities through rating systems. Environment, Development and Sustainability, 15(6): 1573-1591. https://doi.org/10.1007/s10668-013-9462-0
[50] About-de Chastenet, C., Belziti, D., Bessis, B., Faucheux, F., Le Sceller, T., Monaco, F. X., Pech, P. (2016). The French eco-neighbourhood evaluation model: contributions to sustainable city making and to the evolution of urban practises. Journal of Environmental Management, 176: 69-78. https://doi.org/10.1016/j.jenvman.2016.03.036
[51] Likert, R. (1932). A technique for the measurement of attitudes. Archives of Psychology, 22, 140, 55
[52] BRE Global (2012). BREEAM Communities Technical Manual. BRE Global, Watford.
[53] United States Green Building Council (2018). USGBC: LEED v4 for Neighborhood Development. Washington D.C., USA.