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Assessing the sustainable development: A review of multi-criteria decision analysis for urban and architectural sustainability

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Abstract

Sustainable development of cities constitutes nowadays a worldwide goal. Therefore, the related urban and architectural choices must fulfil sustainable objectives. In this context, sustainability assessment presents itself as a key and fundamental element to guide decision-making processes, orienting choices towards actions that make the built environment more sustainable. Among the several existing assessment tools and methods, multi-criteria decision analysis (MCDA) are part of the most widely used approaches to support sustainable decisions. Therefore, this article aims to understand what makes sustainability assessment through MCDA suitable or unsuitable to support decision-making processes in the context of sustainable urban and architectural design and observe how available MCDA methods support this purpose. To do this, a literature review related to MCDA methods in sustainable urban and architectural context has been performed. Descriptive statistics and tables are provided to point out the main trends according to specific research questions. In this sense, it is intended to highlight some potential gaps and points of reflection for future research developments that can support sustainable urban and architectural development.

KEYWORDS
architectural design, multiple criteria decision analysis, sustainability assessment, sustainable development, urban planning

1 | INTRODUCTION

Sustainable urban development constitutes a global goal (Wang & Peng, 2020). Cities, as representative of crucial nodes of action for development, see the concept of sustainability as a lens through which one can conceptualise different environmental, economic and social challenges in urban and architectural design for both new developments and reuse of abandoned sites and buildings (Mecca et al., 2019; Quaglio et al., 2021; Schroeder, 2018): it is indeed translated into specific practices that enable its materialisation.

The concept of sustainable development (SD) is closely linked to that of sustainability assessment (SA), as the purpose of the latter is to assess plans, projects and processes in terms of sustainability. SA can be considered as a generic term involving various processes that aim at integrating sustainability concepts into decision-making (Pope, 2006). In this sense, it can be understood as what steers decision-making towards sustainability (Bond et al., 2012).

SA is defined as a '*a complex appraisal method. It is conducted for supporting decision-making and policy in a broad environmental, economic, and social context, and transcends a purely technical/scientific* *evaluation*' (Sala et al., 2015, p. 314). Thus, it supports and helps decision-makers to direct their choices towards actions that make the built environment more sustainable. Indeed, SA is used to assess the impacts of policies, plans and projects in order to become aware of the extent to which they positively or negatively influence development (Alwaer & Kirk, 2012; Pope et al., 2004).

SA can be used in two different contexts (Adinyira et al., 2007): (i) checking and monitoring the progress of a community, region, nation, or organisation towards sustainability; (ii) evaluating the sustainability of projects, plans or policies prior to their actual realisation. This article focuses on the second case, where SA process involves comparing performance between alternatives or with benchmark values according to one or more criteria (Poveda & Lipsett, 2011).

Since the Brundtland Report, in which the concept of sustainability was introduced in 1987 and as a result of which SD has become the watchword in most discussions and decision-making processes, a number of new assessment tools taken up by the design, planning and construction professions have been developed and made available (Adinyira et al., 2007; Alwaer & Kirk, 2012; Poveda & Lipsett, 2011). Many tools already existed before this date, while others have been developed by academia, industry, and governments in order to support decision-making in sustainable urban development contexts (Brandon & Lombardi, 2010).

Existing assessment tools are specific and appropriate for certain stages of the process or for specific spatial or temporal scales, or for defined sustainable issues (Abastante et al., 2021; Gil & Pinto Duarte, 2013; Mecca et al., 2019). Such analytical tools contribute to conferring and increasing the rigour of the SA, and thus of the choice made between different alternative options, favouring progress towards the sustainable goal (Bond et al., 2012). Hence, the role of assessment tools and methods is to organise information and structure the process, supporting decision-makers in their sustainable choices. In this context, multi-criteria analyses play a central role, as they make it possible to take into account different criteria and indicators in the assessment, which can be expressed not only in monetary terms (Boggia, 2007). Multi-criteria decision analysis (MCDA) methods support the prioritisation of decisions by allowing the simultaneous consideration of multiple criteria (i.e., economic, environmental and social) and the integration of information and perspectives derived from the actors involved in the process (Belton & Stewart, 2002; Bouyssou et al., 2006; Greco et al., 2016; Keeney & Raiffa, 1976). Within the field of valuation in the Italian context, MCDA methods are catalogued as distinct from traditional methods (market value; cost benefit analysis (CBA); social return of investment (SROI); total economic value (TEV); strategic environmental assessment (SEA); environmental impact assessment (EIA), etc.) used for the evaluation of urban and architectural plans and projects (Grillenzoni & Grittani, 1994; Roscelli, 2014). This article intends to focus on MCDA methods following this distinction and thus the questions it will attempt to answer are: what makes MCDA methods suitable or unsuitable for decision support in the context of sustainable urban and architectural design? Are they efficiently applied from the perspective of SD?

In line with this, the aim of the article is to understand what makes SA through MCDA suitable or unsuitable for supporting decision-making processes in the context of sustainable urban and architectural design and to observe how available MCDA methods are currently applied to support this purpose. With this in mind, the article first outlines the characteristics of the sustainable problem at hand, observing the peculiarities that the assessment methods should possess to support the decision toward sustainable urban and architectural design choices. Second, the article provides a review of the literature on the use of MCDA methods in sustainable urban and architectural development contexts to observe how sustainability concepts have been considered so far in decision-making processes concerning the context in question and how MCDA methods have supported them.

The article is organised as follows: the next section describes the characteristic of the sustainable urban and architectural projects, and Section 3 presents the consequent evaluative methodological requirement. Section 4 outlines the methodology used to conduct the literature review. Section 5 details the general results and Section 6 provides the targeted results for sustainable urban and architectural development. Section 7 illustrates the discussion and Section 8 summarizes the conclusion.

2 | THE SUSTAINABLE URBAN AND ARCHITECTURAL PROJECTS

In the context of SD, urban and architectural design constitutes a key element for the green transition (Lami et al., 2022). Indeed, urban and architectural spaces are the crucial nodes in order to improve and achieve sustainability: we can intervene on them, on their outlining from the moment of their design conception, where the choices that will define the nature and quality of the project are made. To support such decision-making with appropriate and targeted evaluative tools, it is necessary to understand specifically which are the peculiarities of the project in a sustainability context. Therefore, following the first artifact of the formal model of the decision aid process introduced in Bouyssou et al. (2006) and Tsoukias (2007), that is, the representation of the problem situation, some issues such as to whom the problem in question belongs, why the problem exists, who is involved and influential on the problem and who will pay for the consequences of the decision, were investigated, and these allowed to highlight some characteristics of the sustainable urban and architectural project.

First, sustainable design, whether urban or architectural, emerges as a more complex problem than approaching a project without considering sustainability reflections. Indeed, when we develop considerations in spatial terms, all different dimensions of sustainability need to be considered: the 2030 Agenda (United Nations General Assembly, 2015), European Green Deal (European Commission, 2019), national and regional sustainable development strategies (e.g., MATTM, 2017), observe and monitor the sustainability of cities on different dimensions, showing that feasibility and sustainability cannot be given only from an economic point of view, but also in terms of a broader value that includes economic, social, environmental and cultural ones. In this sense, urban and architectural space should not be conceived as a space that will generate only an economic return, but as a place that will create over a broad time horizon other values, such as social, environmental and cultural. So, the project, that is, the idea or spatial framework into which the designer or planner inserts various components that he/she considers suitable (Fattinnanzi et al., 2018), should undergo a multi-criteria and all-inclusive evaluation of all sustainable values, steering it in its definition. Related to this, arises the consideration of the importance of implementing a strong sustainability versus the weak sustainability model (Boggia, 2007). The concept of weak sustainability was developed from environmental economics and it is based on the concept of substitutability of different types of capital (economic, social and environmental) (Wilson & Wu, 2016). However, this approach was later opposed by strong sustainability which rejects this concept of substitutability, indeed both economic and social capital are derivatives of environmental capital (Wilson & Wu, 2016). Weak sustainability and strong sustainability perspectives therefore represent two ways of maintaining natural and total capital, understood as the sum of natural and human capital. This implies that equal importance should be given to the development of the different dimensions of sustainability—economic, environmental, social and cultural—even though these are interrelated or in conflict with each other (Sala et al., 2013).

Second, the development of sustainable urban and architectural projects requires a greater responsibility from public and private investors in giving rise to project that can create different types of value. Although this increase in responsibility can be complex to acquire, especially from the perspective of the private party, as it can potentially lead to a greater outlay of money, it is worth noting that the latter could be repaid by positive economic implications: investing in the development of social, environmental and cultural values can lead to the maximization of the profit of the investor (Lami et al., 2022; Mecca et al., 2020). This should be understood in terms of higher market value and lower cost value in the private context, and higher use value and thus higher total economic value in the public context (Lami et al., 2022).

Third, in sustainable design the involvement of stakeholders in the decision-making process is defined as essential (Sala et al., 2013). Indeed, to develop multidimensional sustainability, the involvement of potentially influential and affected actors appears crucial to embrace all points of view and limit the possibility that projects may be the product of a vision limited and filtered through the interests of the investor(s). Accordingly, urban or architectural project consequences, when viewed from the perspective of SD, must be considered from a broader perspective: the environment and society should be taken into account as subjects of equal importance to that of the investor(s). When considering the economic dynamics of profit, especially in a private context, the latter aspect may appear as hardly attainable, however, it should be noted and highlighted that both, society and environment, are affected and influenced by the consequences of project quality and therefore to be safeguarded with a view to common welfare. So, in this sense it would be necessary to analyse and consider the development of values in favour of society and the environment, as elements supporting the development of greater economic value for the benefit of the investor.

3 | DESIRABLE METHODOLOGICAL FEATURES FOR THE EVALUATION OF SUSTAINABLE URBAN AND ARCHITECTURAL DESIGN

Taking into consideration the exposed aspects that characterize sustainable urban and architectural project it is possible to outline some factors or implications which should be considered when conducting a project evaluation, in the perspective of supporting the choice of the most satisfactory project from a sustainable point of view or to guide the construction of sustainable projects.

The fact that a sustainable project appears as a problem of high complexity, due to the need to explore its feasibility from the perspective of several dimensions/values simultaneously—economic, environmental, social and cultural—brings to light two desirable characteristics to contemplate in evaluative methods for decision support:

- Considering several project aspects or elements could mean a complex and differentiated quantification in terms of the units of measurement. The urban and architectural context involves, in particular, multidimensional objectives and criteria, representing both tangible and intangible aspects, which can be expressed according to different units of measurement that allow for an adequate representation of the aspects (Abastante et al., 2020). In this sense, it is essential to take into account different 'mixed' information, that is, both quantified criteria according to qualitative and quantitative units of measurement (Munda, 2005). As far as SD is concerned, it is important that the different aspects are quantified in the most correct way and therefore represented according to the units of measurement that give them an appropriate expression, so the evaluation methods should be able to handle mixed criteria scores. Most of the existing evaluation methods/tools (Market value; CBA; SROI; TEV; etc.) foresee the quantification of economic, social, and environmental aspects in monetary terms: this can be a limitation especially with respect to social and cultural aspects, resulting sometimes in the non-consideration of some aspects as they cannot be quantified in currency (King, 2021). Instead, in the methods categorized under MCDA (Greco et al., 2016) (as already reported, distinctly considered in the Italian evaluation discipline from the previous methods mentioned), the quantification of aspects can take place not only in strictly monetary terms (Roscelli, 2014), but there is the possibility of expressing the value in the most appropriate scale, whether quantitative or qualitative, monetary or nonmonetary.
- Dealing with different values analysed through different indicators involves disposing of tools that can hold together in assessment and aggregate aspects of different nature. Again, existing measurement and evaluation methods/tools, outside of MCDAs, allow the assessment of economic, social, environmental and cultural dimensions/values separately or converging into a single final monetary response, and therefore do not allow the simultaneous measurement and assessment of all four dimensions/values.

Concerning the increased responsibility of investors in the development of urban and architectural projects that can create different types of value—economic, social, environmental, and cultural—this could imply the need for evaluative tools that can support the project definition process, for example, by highlighting the value created for each type. This consideration could also stem from the fact that the sustainable project entails broader consequences, in which the environment and society should potentially carry the same weight as the investor(s). Indeed, such evaluation tools could support strategic assessments of the project under development, taking into consideration multiple, differently interrelated, prioritized and interacting aspects in order to define a project that meets sustainability standards. Currently, there are no evaluation method/tool that fulfil this requirement.

Finally, the essential involvement of stakeholders could imply a final desirable feature of evaluation methods, namely involvement in all stages of evaluation. Methods should be designed in a participatory, interactive way to allow knowledge generation and collaboration of strategy implementation in decision-making processes (Sala et al., 2013). The solutions or alternatives are based on the responsibility of the stakeholders and their involvement takes place in all phases of the evaluation: from the elaboration and structuring of the problems, to the design of the methodology, the definition of the objectives and criteria/indicators and to the application and verification (Sala et al., 2013). Existing evaluation methods/tools in the evaluation literature do not tend to involve stakeholders in all the appraisal stages, and the evaluation is carried out by the appraiser who may use tools such as questionnaires and contingent valuation to obtain information needed for evaluation purposes. Again, an exception can be made for MCDA methods which may involve stakeholders at different stages of the evaluation.

Thus, in a nutshell, it is possible to observe that most of the desirable methodological features are currently already addressed and fulfilled by MCDA methods. However, it emerges that at the moment MCDA methods, as well as traditional evaluation methods/tools, do not seem to allow for the formulation of final information on single values, computed and considered simultaneously, and on the total value created by the project. Therefore, the next section provides a literature review regarding MCDA methods and their applications in order to: (i) observe which are the most used MCDA methods in the sustainable urban and architectural context; (ii) whether they are currently applied from the perspective of SD and whether they are actually used taking into consideration the sustainable project characteristics highlighted in the previous section; (iii) verify that in some cases they cannot be used to provide information on individual values and total value created by the project.

4 | METHODOLOGY

A literature review has been developed with respect to the MCDA methods in sustainable urban and architectural context and the data collection process performed can be seen summarised in Figure 1.

The Scopus database has been chosen to support the literature search and 109 articles have been collected. These articles had been published in the scientific literature since the Agenda 2030's introduction until exactly 10 years before the deadline for achieving the sustainable goals, so from 2015 to 2020. The number of selected articles is not so high since the research has been framed according to a scheme provided below. First, it should be noted that the collection of articles was divided into two: one related to the urban context and the other related to the architectural one. Therefore, the keywords used and searched in the titles, abstracts and keywords are:

- Sustainability; Sustainable Development Goals; Sustainable Development; Multiple Criteria Decision Aiding; multiple criteria; decision-making process; architectural context; architecture; architectural design;

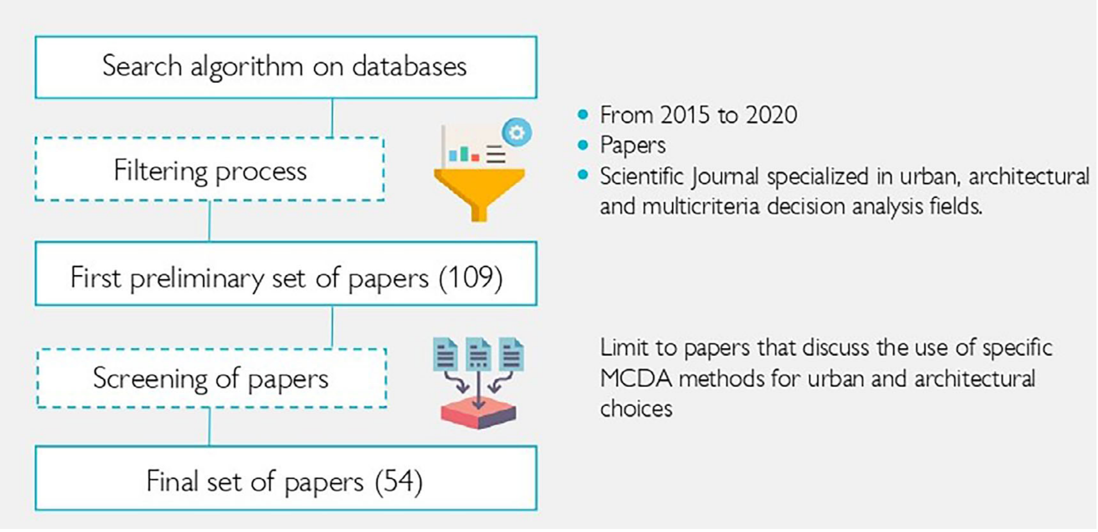

FIGURE 1 Data collection process of the literature review.

- Sustainability; Sustainable Development Goals; Sustainable Development; Multiple Criteria Decision Aiding; multiple criteria; decision-making process; urban context; urban areas; urban planning;

According to the document type the research has been limited only to 'papers', instead the conference paper, editorial and review were excluded from the sample. Moreover, only articles published in scientific Journal specialised in urban, architectural and multicriteria decision analysis fields, such as Cities, Building, Sustainability, Land use policy, Journal Of Architecture And Planning, International Journal Of Multicriteria Decision Making, and so on, have been considered. This process of paper extraction led to a total of 32 articles related to the architectural context and 77 related to the urban context.

These articles have been screened and only the ones dealing with the use of specific MCDA methods to support decision in urban and architectural context were considered. According to this selection, the list of papers which the review will be based on, relies on 54 articles.

The selected papers were analysed according to specific research questions:

- Which MCDA methods are used in the urban and architectural context?
- Which application context are they considered in?
- Which dimensions of sustainability are considered?
- Which criteria and indicators are used for each sustainability dimension?
- Are the criteria and sub-criteria/indicators weighted?
- Is the involvement of stakeholders or experts considered? What for?

Having this in mind, each selected paper has been analysed according to a specific scheme (Table 1).

5 | RESULTS

5.1 | Most used methods in urban and architectural context

The papers analysed consider 24 methods, namely Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981), Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) (Brans & Vincke, 1985), Complex Proportional Assessment (COPRAS) (Zavadskas et al., 1994), Analytic Hierarchy Process (AHP) (Saaty, 1981), ELimination Et Choix Traduisant la REalité (ELECTRE) (Roy, 1991), Analytic Network Process (ANP) (Saaty, 2005), Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) (Bana e Costa & Vansnick, 1997), Visekriterijumska Optimizacija i kompromisno Resenje (VIKOR) (Opricovic, 1998), Evaluation based on distance from the mean solution (EDAS) (Keshavarz Ghorabaee et al., 2015), Delphi method (Bernice, 1968), Decision-Making Trial and Evaluation Laboratory (DEMATEL) (Gabus & Fontela, 1972), EVAluation of MIXed Data (EVAMIX) (Alinezhad & Khalili, 2019), Simple Additive Weighting (SAW) (Fishburn, 1967), Characteristic Objects METhod (COMET) (Watróbski, Sałabun, et al., 2017), Multi-attribute utility theory (MAUT) (Keeney & Raiffa, 1976), Multi-attribute value theory (MAVT) (Keeney & Raiffa, 1976), Sequential Interactive Model for Urban Systems (SIMUS) (Munier, 2011), Best worst method (BWM) (Rezaei, 2015), MAJA method (Jacyna & Wasiak, 2015), Simos Roy Figueira (SRF) method (Figueira & Roy, 2002), Multicriteria Hierarchy Process (MCHP) (Corrente et al., 2012, 2013), Stochastic multicriteria acceptability analysis (SMAA) (Lahdelma et al., 1998), Group Analytic Hierarchy Process (GAHP) (Ottomano Palmisano et al., 2016), Spanish Integrated Value Model for Sustainability Assessment (MIVES) (Vinolas et al., 2009).

Table 2 shows the percentages of use of the various methods, also highlighting options for the joint application of different methods. One can observe that the most used are: first, the AHP method, which proves to be the most used in urban and architectural contexts with 46% of the papers; then the TOPSIS method with 20%, followed by MIVES with 11%; finally, and COPRAS with 9%.

It is noted that in some cases (22 papers), the application of two or more methods is carried out in an integrated way or separately to observe the results from the different methods. Very often, the combination of the different methods is due to the definition and calculation of the weights assigned to the evaluation criteria, sub-criteria and indicators, which is a fundamental and relevant step in almost all applications. This is the case, for instance, in the combination of the AHP and VIKOR, AHP and DEMATEL, AHP, MACBETH and EVAMIX methods where the AHP method and the Saaty scale are used for the weighting process of the criteria. Similarly, the conjunction of fuzzy COPRAS and BWM, and of ELECTRE, MCHP, SRF and SMAA methods sees the use of BWM and SRF methods for the elicitation of preferences and weights. For the interest of potential readers Table 3 provides a list of the journals which the reviewed documents have been published in.

5.2 | Sustainability dimensions considered in urban and architectural context

Before illustrating the data distribution with respect to the sustainability dimensions, it is necessary to make a methodological note. Many papers (15) do not directly express the sustainable dimensions of reference or in many cases do so in a non-explicit manner, grouping the

TABLE 1 Classification scheme.

Reference	MCDA methods used	Context	Sustainability dimensions			Means of judging			Weighted criteria	Stakeholder involvement	
			Env.	Eco.	Soc.	Criteria	Sub-criteria	Indicators		Who	How

TABLE 2 Use of the different MCDA methods in the applications considered in the reviewed sample.

Method used			N. of papers	Total use of the method	%	References
AHP	Single use	AHP	12	25	46%	Bivina and Parida (2020), Carli et al. (2018), Dabouh and Shazly (2020), Fernandes et al. (2018), Ghorbanzadeh et al. (2018), Kioussi et al. (2020), Lehner et al. (2018), Ozge Balta and Ulgen Yenil (2019), Campisi et al. (2020); Paredes and Herrera (2020); Semanjski and Gautama (2019), and Stankovic et al. (2018)
	Combined use	AHP + TOPSIS*	2			Guzman-Sanchez et al. (2018) and Taleai and Amiri (2017)
		AHP + Kendall rank	1			Duleba and Moslem (2018)
		AHP + GIS	1			Türk (2017)
		AHP + DEMATEL*	1			Kijewska et al. (2018)
		AHP + MACBETH + EVAMIX*	1			Della Spina (2020)
		AHP + VIKOR*	1			Kripka et al. (2019)
		AHP + fuzzy DELPHI*	1			Aigwi et al. (2019)
		AHP + DELPHI* + GIS	1			Ristic et al. (2018)
		AHP, TOPSIS, SAW, COPRAS*	1			Zapolskyte et al. (2020)
		AHP, ELECTRE, TOPSIS, VIKOR*	1			Nesticò and Somma (2019)
		AHP + MAUT	1			Asadi et al. (2020)
		AHP, TOPSIS; Choquet integral	1			Moghtadernejad et al. (2018)
TOPSIS	Single use	TOPSIS	3	11	20%	Al-Kaabi et al. (2020), de Oliveira Campos et al. (2020), and Jia et al. (2018)
	Combined use	AHP + TOPSIS	2			Guzman-Sanchez et al. (2018) and Taleai and Amiri (2017)
		COMET + TOPSIS + VIKOR*	1			Shekhovtsov et al. (2020)
		SAW + COPRAS + TOPSIS + EDAS*	1			Bielinskas et al. (2018)
		AHP, ELECTRE, TOPSIS, VIKOR*	1			Nesticò and Somma (2019)
		PROMETHEE II + fuzzy TOPSIS*	1			Watróbski, Malecki, et al. (2017)
		AHP, TOPSIS, SAW, COPRAS*	1			Zapolskyte et al. (2020)
		AHP, TOPSIS, Choquet integral	1			Moghtadernejad et al. (2018)
MIVES	Single use	MIVES	6	6	11%	Caballero Moreno et al. (2019), Gandini et al. (2020), Hosseini et al. (2020), Oses et al. (2017), Pons et al. (2016), and Pujadas et al. (2017)
	Combined use	–	0			–
COPRAS	Single use	COPRAS	1	5	9%	Diciunaite-Rauktiene et al. (2018)
	Combined use	Fuzzy COPRAS + BWM	1			Mahdiraji et al. (2018)
		COPRAS + LCA + LCC	1			Invidiata et al. (2018)
		SAW + COPRAS + TOPSIS + EDAS*	1			Bielinskas et al. (2018)

TABLE 2 (Continued)

Method used			N. of papers	Total use of the method	%	References
		AHP, TOPSIS, SAW, COPRAS*	1			Zapolskyte et al. (2020)
PROMETHEE	Single use	PROMETHEE I	1	4	7%	Kiba-Janiak and Witkowski (2019)
		PROMETHEE II	2			Milan et al. (2015) and Cerreta et al. (2020)
	Combined use	PROMETHEE II + fuzzy TOPSIS*	1			Watróbski, Malecki, et al. (2017)
VIKOR	Single use	VIKOR	0	3	6%	–
	Combined use	COMET + TOPSIS + VIKOR*	1			Shekhovtsov et al. (2020)
		AHP, ELECTRE, TOPSIS, VIKOR	1			Nesticò and Somma (2019)
		AHP + VIKOR*	1			Kripka et al. (2019)
SAW	Single use	SAW	1	3	6%	Yi et al. (2018)
	Combined use	SAW + COPRAS + TOPSIS + EDAS*	1			Bielinskas et al. (2018)
		AHP + TOPSIS + SAW + COPRAS*	1			Zapolskyte et al. (2020)
DELPHI	Single use	DELPHI	0	2	4%	–
	Combined use	AHP + DELPHI* + GIS	1			Ristic et al. (2018)
		AHP + fuzzy DELPHI*	1			Aigwi et al. (2019)
COMET	Single use	COMET	1	2	4%	Salabun et al. (2019)
	Combined use	COMET + TOPSIS + VIKOR*	1			Shekhovtsov et al. (2020)
ELECTRE	Single use	ELECTRE I, II, III, IV, TRI, IS	0	2	4%	–
	Combined use	ELECTRE III + MCHP + SRF + SMAA	1			Abastante et al. (2020)
		AHP, ELECTRE, TOPSIS, VIKOR	1			Nesticò and Somma (2019)
MAUT	Single use	MAUT	1	2	4%	del Mar Casanovas-Rubio et al. (2020)
	Combined use	AHP + MAUT	1			Asadi et al. (2020)
ANP	Single use	ANP	1	1	2%	Haruna et al. (2020)
	Combined use	–	0			–
MAVT	Single use	MAVT	0	1	2%	–
	Combined use	SA + Nara Grid + MAVT	1			Capolongo et al. (2019)
MAJA method	Single use	MAJA method	1	1	2%	Ciesla et al. (2020)
	Combined use	–	0			–
SIMUS method	Single use	SIMUS method	1	1	2%	Stoilova et al. (2020)
	Combined use	–	0			–
BWM	Single use	BWM	1	1	2%	Moslem et al. (2020)
	Combined use	–	0			–
WS	Single use	WS + GIS	1	1	2%	Papadopoulou and Hatzichristos (2020)
	Combined use	–	0			–

(Continues)

TABLE 2 (Continued)

Method used			N. of papers	Total use of the method	%	References
GAHP	Single use	GAHP	0	1	2%	–
	Combined use	GAHP + GIS	1			Ottomano Palmisano et al. (2016)
DEMATEL	Single use	DEMATEL	0	1	2%	–
	Combined use	AHP + DEMATEL	1			Kijewska et al. (2018)
MACBETH	Single use	MACBETH	0	1	2%	–
	Combined use	AHP + MACBETH + EVAMIX*	1			Della Spina (2020)
EVAMIX	Single use	EVAMIX	0	1	2%	–
	Combined use	AHP + MACBETH + EVAMIX*	1			Della Spina (2020)
EDAS	Single use	EDAS	0	1	2%	
	Combined use	SAW + COPRAS + TOPSIS + EDAS*	1			Bielinskas et al. (2018)

Note: The methods marked with * have been repeated several times in the table, in order to define the percentages of use, as combined methods involve more than one method. For instance, the PROMETHEE + TOPSIS combination has been reported and considered for the quantification of applications using both the PROMETHEE and TOPSIS methods. And so on for all other combined methods.

criteria, sub-criteria, and indicators under dimensions/categories with different names specific to the contexts analysed, such as, for instance, urban sustainability, project sustainability, functional sustainability, architectural aspects, and so on. Therefore, in order to uniformly read the data and to be able to effectively take into consideration the dimensions of sustainability, the criteria, sub-criteria and indicators have been considered in such a way as to conceptually lead them back to the sustainable reference dimension codified in the literature—economic, environmental, social and cultural (Axelsson et al., 2013; Shi et al., 2019; Shirazi & Keivani, 2017; United Nations, 1987). Table 4 briefly summarises the dimensions considered by the different papers.

About half of the reviewed papers (26) consider the three main dimensions of sustainability, that is, economic, environmental and social, and five papers consider all the four dimensions.

However, 39% of the sample (21 papers) develop evaluation considering only some dimensions, indeed: a limited number of papers (8) explore only one of the dimensions; in some cases (11 papers), only some pairs of certain dimensions are considered.

It is relevant to note that about 80% of the articles observed, specifically 43 papers, consider and explore the social dimension, which only in the last decades, has gained attention as a fundamental component of the SD (Lami & Mecca, 2021). It is also interesting to observe that the cultural dimension appears in seven articles. The concept of cultural sustainability is even less explored than the social one and within the social sustainability debate, two critical groups stand out (Lami & Mecca, 2021), one of which advocates precisely the possible revision of the SD framework by proposing a structure with four or more pillars, including the cultural one (Shirazi & Keivani, 2017).

As evidence of this, it is relevant to note that, even in a restricted sample specific to the urban and architectural context, the social dimension has acquired a more recognised and explored position, and above all there is a small but important presence of applications that consider the cultural dimension in studies in favour of SD.

Taking a deeper look at this dimension, it can be observed that with respect to the architectural context this dimension refers to aspects such as cultural identity, the cultural significance of the place, the historical life cycle of the building or the functional mix (Aigwi et al., 2019; Capolongo et al., 2019). With respect to the urban context, it is observed that in one study (Diciunaite-Rauktiene et al., 2018) within the social macro-criterion, there is a cultural criterion that observes and quantifies cultural spaces understood as the aesthetic appearance of streets, buildings, and architectural and cultural monuments. In general, therefore, these cultural aspects are more related to the architectural context and linked to the theme of the genius loci (Norberg-Schulz, 1980) that characterises the building and its surroundings. Indeed, the cultural dimension considers an ideological one, which includes intangible elements that are difficult to quantify such as values, ideals, heritage, and expectations (Chiu, 2004).

Moreover, it is important to note that one of the reviewed papers (Aigwi et al., 2019) considers all four dimensions plus a dimension related to 'regulatory aspects'. The latter considers criteria related to compliance with building code requirements, environmental and

TABLE 3 List of journals where the reviewed documents have been published.

References	n. Papers	Journals
Al-Kaabi et al. (2020), Campisi et al. (2020), Capolongo et al. (2019), del Mar Casanovas-Rubio et al. (2020), Cerreta et al. (2020), Ciesla et al. (2020), de Oliveira Campos et al. (2020), Della Spina (2020), Diciunaite-Rauktiene et al. (2018), Duleba and Moslem (2018), Ghorbanzadeh et al. (2018), Jia et al. (2018), Kiba-Janiak and Witkowski (2019), Kijewska et al. (2018), Kripka et al. (2019), Lehner et al. (2018), Mahdiraji et al. (2018), Moslem et al. (2020), Nesticò and Somma (2019), Paredes and Herrera (2020), Pons et al. (2016), Salabun et al. (2019), Semanjski and Gautama (2019), Shekhovtsov et al. (2020), Stankovic et al. (2018), Stoilova et al. (2020), Watróbski, Sałabun, et al. (2017), Watróbski, Malecki, et al. (2017), Yi et al. (2018), and Zapolskyte et al. (2020)	29	Sustainability
Guzman-Sanchez et al. (2018), Hosseini et al. (2020), and Invidiata et al. (2018)	3	Building and Environment
Ottomano Palmisano et al. (2016), Ozge Balta and Ulgen Yenil (2019), and Pujadas et al. (2017)	3	Land Use Policy
Bivina and Parida (2020)	1	Environment, Development and Sustainability
Kioussi et al. (2020)	1	International Journal of Architectural Heritage
Papadopoulou and Hatzichristos (2020)	1	International Journal of E-Planning Research
Milan et al. (2015)	1	International Journal of Multicriteria Decision Making
Fernandes et al. (2018)	1	International Journal of Sustainable Development & World Ecology
Moghtadernejad et al. (2018)	1	Journal of Building Engineering
Asadi et al. (2020)	1	Journal of Building Performance Simulation
Bielinskas et al. (2018)	1	Journal of Civil Engineering and Management
Dabouh and Shazly (2020)	1	Journal of Engineering and Applied Science
Carli et al. (2018) and Ristic et al. (2018)	2	Journal of Environmental Management
Oses et al. (2017)	1	Journal of Environmental Planning and Management
Haruna et al. (2020)	1	Journal of Engineering and Technological Sciences
Abastante et al. (2020)	1	Operational Research
Türk (2017)	1	Planning Practice & Research
Aigwi et al. (2019), Gandini et al. (2020), and Taleai and Amiri (2017)	3	Sustainable, Cities and Society
Caballero Moreno et al. (2019)	1	The Journal of Housing and the Built Environment

safety requirements, and various technical demands. It is interesting and equally strange that in the urban context these elements are never considered in the reference sample.

6 | TARGETED RESULTS FOR SUSTAINABLE URBAN AND ARCHITECTURAL DEVELOPMENT

Referring to the four most widely used methods, that is, AHP, TOPSIS, MIVES and COPRAS, some characteristics are observed in the application reviewed in order to understand whether they have the desirable and useful characteristic to support the development of sustainable urban and architectural projects and whether these are really exploited and considered in the observed applications for SD.

Regarding the AHP method (Aigwi et al., 2019; Asadi et al., 2020; Bivina & Parida, 2020; Campisi et al., 2020; Carli et al., 2018; Dabouh & Shazly, 2020; Della Spina, 2020; Duleba & Moslem, 2018; Fernandes et al., 2018; Ghorbanzadeh et al., 2018; Guzman-Sanchez et al., 2018; Kijewska et al., 2018; Kioussi et al., 2020; Kripka et al., 2019; Lehner et al., 2018; Moghtadernejad et al., 2018; Nesticò & Somma, 2019; Ozge Balta & Ulgen Yenil, 2019; Paredes &

TABLE 4 Sustainability dimensions considered in the sample.

Dimension considered	n. Papers	References
Environmental, Economic, Social	26	Al-Kaabi et al. (2020), Asadi et al., 2020, Bielinskas et al. (2018), Caballero Moreno et al. (2019), Carli et al. (2018), Cerreta et al. (2020), Ciesla et al. (2020), De Oliveira Campos et al. (2020), Diciunaite-Rauktiene et al. (2018), Fernandes et al. (2018), Guzman-Sanchez et al. (2018), Hosseini et al. (2020), Invidiata et al. (2018), Jia et al. (2018), Kiba-Janiak and Witkowski (2019), Lehner et al., 2018, Milan et al. (2015), Moghtadernejad et al. (2018), Oses et al. (2017), Paredes and Herrera (2020), Pons et al., 2016, Pujadas et al., 2017, Stankovic et al., 2018, Türk, 2017, Yi et al., 2018, and Zapolskyte et al., 2020
Environmental, Economic, Social, Cultural	5	Capolongo et al. (2019), Dabouh and Shazly (2020), Gandini et al. (2020), Guzman-Sanchez et al. (2018), and Kioussi et al. (2020)
Economic, Social, Cultural	2	Aigwi et al. (2019) and Nesticò and Somma (2019)
Environmental, Economic	6	Kijewska et al. (2018), Kripka et al. (2019), Mahdiraji et al. (2018), Salabun et al. (2019), Shekhovtsov et al. (2020), Watróbski, Sałabun, et al. (2017), and Watróbski, Malecki, et al. (2017)
Environmental, Social	3	Ozge Balta and Ulgen Yenil (2019), Papadopoulou and Hatzichristos (2020), and Taleai and Amiri (2017)
Economic, Social	2	Abastante et al. (2020) and Della Spina (2020)
Environmental	2	Haruna et al. (2020) and Ristic et al. (2018)
Economic	1	Stoilova et al. (2020)
Social	5	Bivina and Parida (2020), Campisi et al. (2020), Duleba and Moslem (2018), Ghorbanzadeh et al., 2018, and Moslem et al. (2020)
No reference to the three dimensions (reference to technical dimension)	2	del Mar Casanovas-Rubio et al. (2020) and Semanjski and Gautama (2019)

Herrera, 2020; Ristic et al., 2018; Semanjski & Gautama, 2019; Stankovic et al., 2018; Taleai & Amiri, 2017; Türk, 2017; Zapolskyte et al., 2020), it emerges as the most popular probably because of the greater simplicity of calculation and the availability of a software (Expert Choice) that supports its application and calculation. Referring to this method it can be highlighted that:

- The method allows to consider different dimensions and to intersect them in different ways, however, looking at the sample data, the applications that analyse all dimensions of sustainability are only three. Nine consider environmental, economic and social dimensions and indicators/criteria. Two observe only economic and environmental dimensions, two the environmental social ones, and one considers the economic and social dimensions. Finally, five focus on one dimension only, four on the social dimension and one focuses on the environmental one.
- The different criteria of the applications considered have different units of measurement according to the different objectives and criteria defined for the analysis of tangible and intangible aspects. Therefore, it is observed that the method can allow an evaluation with different and multidimensional indicators/criteria that are made explicit through the most appropriate units of measurement.
- The observed documents related to the application of the AHP method mainly foresee the involvement of stakeholders in one or two phases of the evaluation: eight involve them for the elicitation of preferences and therefore for the definition of the criteria weights (Aigwi et al., 2019; Asadi et al., 2020; Bivina & Parida, 2020; Carli et al., 2018; Dabouh & Shazly, 2020; Duleba & Moslem, 2018; Kijewska et al., 2018; Semanjski & Gautama, 2019; Taleai & Amiri, 2017) and three foresee the involvement both in the phase of definition of the weights and in the previous one of obtaining useful information from the interviewees (Campisi et al., 2020; Ghorbanzadeh et al., 2018; Zapolskyte et al., 2020). Moreover, in five cases, actors are involved in relation to the weights of the criteria but also in the definition of the evaluation criteria themselves, which are outlined on the basis of the experts' knowledge (Fernandes et al., 2018; Kioussi et al., 2020; Ozge Balta & Ulgen Yenil, 2019; Ristic et al., 2018; Stankovic et al., 2018). In one case the experts are involved in the definition of the alternative or in gathering information about the problem in order to define the project of intervention, and for the elicitation of the weights (Türk, 2017). One case foresees the involvement of the stakeholders in three stages of the evaluation, namely the collection of information, the definition of the indicators and the elicitation of preferences (Guzman-Sanchez et al., 2018). In one case the actors supported only in the definition of the most suitable criteria/indicators for the evaluation of the alternatives (Lehner et al., 2018) and in one case the involvement took place on more than one stage, that is, for the collection of information for the construction of the alternatives, for the choice of the functions of the architectural scenarios, for the selection and definition of the criteria and finally for the elicitation of the weights of the latter (Della Spina, 2020). Four cases do not involve experts.

Based on this it can be observed that although the AHP method, like the other MCDA methods, can provide for a more comprehensive involvement in the different phases of the evaluation, it is also observed that this is limited in most cases to the elicitation of weights, therefore, to a part of the application. Few cases foresee the interaction with the actors in the elaboration of the problems and in the definition of the criteria/indicators. In this sense it is not possible to affirm that evaluations through the AHP method follow an efficient strategy with respect to the setting up of a participatory process as defined and proposed at a theoretical level for a sustainable process.

The second most popular method according to the analysed set is the TOPSIS method (Al-Kaabi et al., 2020; Bielinskas et al., 2018; de Oliveira Campos et al., 2020; Jia et al., 2018; Shekhovtsov et al., 2020; Watróbski, Malecki, et al., 2017; Zapolskyte et al., 2020). As in the case of AHP, it constitutes an intuitive and easy to understand method which makes it simple to apply (Çelikbilek & Tüysüz, 2020; Zavadskas et al., 2016). Referring to this method it can be highlighted that:

- Criteria from all dimensions of sustainability—economic, social, and environmental—are considered in almost all applications. This makes it suitable for observing and analysing scenarios with respect to different dimensions, which can be intersected and weighted differently according to the preferences of decision-makers.
- As far as the units of measurement are concerned, the method allows the use of different units, but in numerical expression, since the performance matrix needs to be normalised according to the application steps of the model. This may imply a limitation of expression and quantification of qualitative variables, which may emerge especially in the context of urban and architectural assets. These, indeed, can be very specific to the context of reference, difficult to quantify and therefore require particular qualitative units of measurement that grant an appropriate expression (Abastante et al., 2020). Furthermore, reflecting for instance on what is reported in de Oliveira Campos et al. (2020), in which the gradation scale of a relative criterion is converted from qualitative indices (high reduction, moderate reduction, indifference, moderate increase, etc.) to quantitative indices (1, 2, 3, and 4, etc.), a possible criticality can be hypothesised. Indeed, this conversion could potentially prove in certain cases, such as aesthetic criteria, impact on architectural value, and so on, to be complex and not shared by all: for instance, why should we generally all agree that a qualitative value of 'low impact' on the architectural value of a building should be converted into a quantitative numerical value equal to 1? The basic assumptions of conversion can be clarified and varied from case to case according to the subjectivity of the decision-maker, however, in the presence of several decision-makers this could lead to a critical point. This aspect of qualitative evaluations has been addressed by Corrente and Tasiou (2023), who propose an extension of the TOPSIS method to take such information into account.
- In applications involving the TOPSIS method, it is noted that an efficient participatory process is not adopted as enunciated at the theoretical level, that is to say at all stages of evaluation. Indeed, in four cases, the involvement of decision-makers in the process is not envisaged (Al-Kaabi et al., 2020; Bielinskas et al., 2018; Moghtadernejad et al., 2018; Watróbski, Malecki, et al., 2017); in three cases, stakeholders are considered at one stage of the evaluation, namely in relation to the elicitation of weights (de Oliveira Campos et al., 2020; Taleai & Amiri, 2017; Zapolskyte et al., 2020); in one case, experts are involved in order to assess the importance of each criterion and the performance of the scenarios (Jia et al., 2018); finally, in one case, involvement takes place in relation to the COMET method, applied in conjunction with TOPSIS, in order to define the dimensions of the problem, to assess the characteristic objects through pairwise comparison and to determine the matrix of judgements (Shekhovtsov et al., 2020). Based on this, it can be observed that the evaluations using the TOPSIS method were not carried out according to a participatory process except in a few cases for individual steps in the participation process, especially for the weighting of criteria.

The third most popular method according to the analysed set is MIVES (Caballero Moreno et al., 2019; Gandini et al., 2020; Hosseini et al., 2020; Oses et al., 2017; Pons et al., 2016; Pujadas et al., 2017). This tool was created precisely in favour of sustainability, in the desire to support the evaluation, prioritization, and selection of alternatives toward SD in the construction context (Boix-Cots et al., 2022). Referring to this method it can be highlighted that:

- Developed in the perspective of SD, this method allows the consideration and correlation of different dimensions (Boix-Cots et al., 2022). The papers analysed allow to observe that, indeed, in all applications in which it has been used, the three main dimensions of SD—economic, environmental and social—have been observed and related. In addition, Gandini et al. (2020) also consider the cultural dimension, and Oses et al. (2017) consider separately and in addition to the dimensions of sustainability, a technical dimension specific to the reference construction context.
- Regarding the units of measurement which the indicators are expressed with, it is noted that in this case also the method was conceived with a view to allowing the consideration of different units of measurement. Indeed, it involves the construction of a value function that allows the qualitative and quantitative variables of the indicators, with their different units of measurement, to be converted into a single a-dimensional scale (between 0 and 1), leading to the definition of an index of sustainability of the alternative(s) evaluated (Boix-Cots et al., 2022; Josa et al., 2020). Indeed, the documents analysed, consider different indicators for each dimension observed and evaluated, which are quantified through different units of measurement (Caballero Moreno et al., 2019; Gandini et al., 2020; Hosseini et al., 2020; Oses et al., 2017; Pons et al., 2016; Pujadas et al., 2017).

- MIVES is used for multi-stakeholders perspectives (Gandini et al., 2020), however, even for this method it is possible to observe from the analysed papers that the involvement of experts mainly occurs for the elicitation of preferences and weights (Caballero Moreno et al., 2019; Gandini et al., 2020; Hosseini et al., 2020; Oses et al., 2017; Pons et al., 2016; Pujadas et al., 2017). In three cases (Caballero Moreno et al., 2019; Oses et al., 2017; Pons et al., 2016), the stakeholder's involvement also occurs at another stage of the evaluation, namely, for the definition of the criteria and indicators to be used for the evaluation. In this case, applications include the involvement of experts through workshops or questionnaires to identify the most appropriate criteria and indicators.

The fourth most widely used method is the COPRAS method (Bielinskas et al., 2018; Diciunaite-Rauktiene et al., 2018; Invidiata et al., 2018; Mahdiraji et al., 2018; Zapolskyte et al., 2020), which is also characterised by an easy procedure that makes it simple and intuitive in its application (Mahdiraji et al., 2018; Tupenaite, 2010). Referring to this method it can be highlighted that:

- This method allows also to take into account several categories in the assessment and in this case we can observe that: three out of four applications develop the assessment taking into account the three dimensions of sustainability—economic, social and environmental—while one (Mahdiraji et al., 2018) focuses on the environmental and economic dimensions, taking into account also the technical and architectural dimensions.
- Moreover, the COPRAS method allows the use of different qualitative and quantitative units of measurement (Tupenaite, 2010), thus allowing freedom in expressing the different criteria in the most appropriate way. However, as with the TOPSIS method, the performance matrix is expected to be normalised (Tupenaite, 2010). This implies the need for an expression in qualitative or quantitative numerical scales which can, as expressed for the previous method, potentially lead to a critical point in the quantification of the criteria.
- In applications involving the COPRAS method, either in a single mode or in composition with other methods, a participatory process involving stakeholders at all stages of the assessment is not developed. We can observe that in most cases (Diciunaite-Rauktiene et al., 2018; Invidiata et al., 2018; Mahdiraji et al., 2018; Zapolskyte et al., 2020) stakeholders are involved only for the definition of criteria weights and in one case no involvement is envisaged (Bielinskas et al., 2018).

7 | DISCUSSION

This section will discuss the results presented, observing how the actual application and use of the MCDA methods (Sections 5 and 6) support the development of sustainable projects, considering the desirable characteristics defined in Section 3. In this sense, it is intended to highlight some gaps and potential points of reflection for future research that can support the development of sustainable urban and architectural design alternatives.

The review allows us to observe that about 57% of the sample consider in most cases the three established dimensions of sustainability—economic, social and environmental—and in the other cases all four dimensions, including the cultural one. It should be noted, however, that about 39% focus on a few dimensions only, developing assessments with respect to one or two dimensions. Looking in detail at the most widely used methods—AHP, TOPSIS, MIVES and COPRAS—it can be observed that all of them, as per the characteristic of MCDA methods, allow to develop assessments considering the different sustainable dimensions and thus to intersect them differently according to the preferences of decision-makers. However, while the applications developed through TOPSIS, MIVES and COPRAS consider the three and sometimes four dimensions of sustainability, in the case of AHP, which is the most widely used method, it is observed instead that 40% consider only two or even one dimension in the assessment.

Almost all methods allow for the use of different units of measurement between criteria, facilitating appropriate quantification of different aspects. Indeed, this happens more freely for the use of AHP, MIVES and COPRAS, whereas for TOPSIS only numerical units of measurement are allowed, that can potentially limit freedom and accuracy of expression.

However, although the four most widely used methods appear to have the potential to support the development of sustainable urban and architectural projects—as they allow for the consideration and aggregation of different dimensions and criteria and for the use of different units of measurement—it should be noted that, according to the results of the review, as much as experts involvement is a crucial issue in the sustainable context, the participatory evaluation process does not currently appear to be taking place as effectively as expected. Indeed, in most cases stakeholders are involved with the aim of eliciting the weights of criteria and indicators. In a few other cases, involvement takes place in other phases of the evaluation process, such as the elaboration of problems and the definition of criteria and indicators.

Although theoretically a reflection on the development of weak sustainability and strong sustainability strategies is recommended in order to act carefully and contribute positively to development, none of the observed applications seem to make such a reflection explicit. The assessments occur from the perspective of sustainable development, but do not seem to report reflections with respect to which sustainable paradigm is being pursued in the evaluation in order to justify the different weighting assigned to the dimensions. Indeed, someone may consider the environmental dimension to be the life support of development, others may focus on the sustainability of the economic resources employed and obtained in transformations, and others may consider the well-being of people to be more important. These differences of thought or of preference reflect on the weighting schemes in the evaluation of urban and architectural projects and transformations by giving more importance or less to the different dimensions of sustainability.

Finally, the sample reviewed made it possible to observe that the methods under analysis do not provide quantitative or qualitative information on the value created by the urban or architectural design intervention. Indeed, they provide a ranking of the alternatives considered or allow the identification of the most satisfying alternative according to the preferences of the decision maker. However, for the moment, they do not provide information on the value created by the project or different information on the different individual values created—economic, environmental, social and cultural—which the investor could reflect on taking into consideration his or her personal interests (economic) and those of the planet and society (environmental, social and cultural). However, it is relevant to note that the MIVES method appears to be a very close method to this concept, indeed it involves evaluating each of the alternatives by defining a final sustainability index, which allows us to observe the adequacy of the alternative in terms of sustainability.

8 | CONCLUSION

The article attempts to answer the questions: what makes MCDA methods suitable or unsuitable for decision support in the context of sustainable urban and architectural design? Are they efficiently applied from the perspective of SD?

Concerning the first questions, we can observe that in general the MCDA methods are suitable to support decision making in the context of sustainable urban and architectural projects since: (i) all methods allow the consideration of different dimensions/values and thus a multidimensional and all-inclusive assessment of the different dimensions of sustainability; (ii) some methods enable the use of different units of measurement for quantifying different indicators, fostering a freer and more appropriate expression and quantification of the tangible and intangible aspects that characterize the architectural and urban design context; (iii) all methods potentially allow for the involvement of stakeholders in the different steps of the evaluation, that is, from the elaboration and structuring of the problems to the design of the methodology, to the definition of the objectives and criteria/indicators, and finally to the application and verification; (iv) all methods allow for the development of reasoning on weighting among the different criteria/indicators, and dimensions.

However, none of these allows to get to an understanding of the value created by the architectural or urban project for the city by means of highlighting as well how much value is created with respect to each individual dimension-economic, environmental, social and cultural.

The article analyses a sample of application documents of MCDA methods, noting that the main methods most widely used are AHP, TOPSIS, MIVES and COPRAS. On the basis of the analysis of the latter, it tends to answer the second question, noting that these are not always efficiently applied from the perspective of SD, indeed: (i) in none of the applications can we find the reflection towards developing a strong or weak sustainability paradigm made explicit; (ii) in general, no strong justification is given for the choice of method used considering the characteristics of the problem, such as the rationale behind the different weighting or the choice of compensation or non-compensation between criteria; (iii) stakeholders' involvement almost never occurs through all the phases of the assessment, but tends to be limited to the phases related to the elicitation of weights and in this sense is not currently as efficiently developed as theorised; (iv) finally, one of the most widely used methods—TOPSIS—allows the quantification of indicators only through numerical units of measurement, thus leading to the assumption that in some cases such quantification is complex with respect to certain indicators of the architectural and urban design context and thus quantification of the latter may be limited or not considered.

In this context, it is observed that the current use of MCDA methods to evaluate architectural and urban design is not fully satisfactory from the perspective of SD, seeing that they are sometimes applied for this purpose but without considering reflections on elements such as those mentioned above. However, some limitations of this work are acknowledged, first the restricted nature of the sample which the reflections are outlined on, imposed by specific predefined filtering criteria; second, the reflections depend on the results reported in the literature and considered on the basis of defined research parameters and screening methods.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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