Evaluating the Urban Quality Through a Hybrid Approach: Application in the Milan (Italy) City Area

Oppio Alessandra[1(✉)], Bottero Marta[2], Dell'Anna Federico[2], Dell'Ovo Marta[3], and Gabrielli Laura[4]

[1] Department of Architecture and Urban Studies, Politecnico Di Milano, Via Bonardi 3, 20133 Milan, Italy
alessandra.oppio@polimi.it

[2] Department of Regional and Urban Studies and Planning, Politecnico di Torino, Corso Mattioli 39, 10125 Turin, Italy

[3] Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, via Bonardi 9, 20133 Milan, Italy

[4] Department of Architecture and Arts, IUAV University of Venice, Dorsoduro 2206, 30123 Venice, Italy

Abstract. Urban planning can support the optimal exploitation of the resources available in an urban system with specific reference to the accessibility of goods and services by an increase of the quality of the public space. In this perspective, knowing the economic effects generated by urban planning choices can be fundamental to guide decision-making processes. For this purpose, a research work which proposes a method for defining a synthetic index through the Multi-Attribute Value Theory to describe urban quality is presented. The synthetic index proposed in this study reflects the public open spaces, accessibility and provision of services qualities of the urban context. Besides, this study estimates these advantages through the hedonic prices method, analyzing the residential market. The combined methodology has been applied in detail to three districts located in the Municipality of Milan (Italy). The simultaneous reading of the indices used to spatialise the urban quality levels allows identifying the extrinsic characteristics of the three neighbourhoods analyzed. Considering the changes induced on house prices, the results of the hedonic models show that the economic impacts generated by low levels of urban quality are significant. Accordingly, the policies that aim to transform the existing urban fabric become fundamental for the creation of economic and social value.

Keywords: Multi-criteria decision analysis · Hedonic prices method · Urban policy

1 Introduction

The 17 Sustainable Development Goals (SDGs) adopted in 2015 by all United Nations Member States highlighted how cities today represent the most challenging context for

© Springer Nature Switzerland AG 2020
O. Gervasi et al. (Eds.): ICCSA 2020, LNCS 12253, pp. 300–315, 2020.
https://doi.org/10.1007/978-3-030-58814-4_21

quality of life, environmental sustainability, health and social inclusion. Their strategic role in ensuring the quality of life in our society and the wellbeing of the population is moreover described by the Lancet 2019 Report - an annual update about five fields of research (climate change impacts, exposures and vulnerability; adaptation, planning and resilience for health; mitigation actions and health co-benefits; economics and finance; public and political engagement). Today, 55% of the population lives in an urban area, and the percentage is expected to increase to 68% by 2050 [1]. In this context, sustainable urbanization is the key to sustain and manage the negative consequences related to this trend and, in fact, the 11th SDG is focused on promoting more inclusive, resilient and sustainable cities in order to improve their overall quality. Moreover, the effects of urban quality involves different dimensions – social, environmental, economic – as well as multiple scales – regional, metropolitan, sub-metropolitan, neighbourhood [2].

The current contribution aims at assessing the value of the urban quality by considering both multi-dimensional aspects and the marginal price, in order to explore its connection with home prices.

Many studies have been carried on to prove the correlation between property prices and extrinsic (location, neighbourhood's quality, etc.) as well as intrinsic (structural features, systems, etc.) characteristics [3–5]. D'Acci [4, 6] provided an in-depth literature review aimed at showing how the quality of the location influences the property prices such as the proximity to green spaces, a pleasant view, the quality of the open spaces, the presence of traffic, noise, pollution, the accessibility, the proximity to services etc. The concept of urban quality considered within this research is the one connected with the concept of urban design in order to better focus on how cities can be planned and answer to contemporary demands. In detail, by analyzing the definition of urban quality provided by urban design studies presented by Oppio et al. [7, 8], the paper will focus on the contribution of public open spaces, accessibility and provision of services to the urban quality of three different neighbourhoods located in the city of Milan (Italy) to understand how it finally influences the house market price. The study proposes a multi-methodological evaluation framework based on the integration of a Multi-Attribute Value Theory (MAVT) model [9] with the hedonic prices (HP) method [10].

The paper is divided into six sections. After an introduction where the research question has been elicited, the second section will present the integrated evaluation framework composed by the spatial analysis and HP method; the third one will introduce the case study while the fourth one the application of the two methodologies. Section five and six are devoted to the discussion of the results and the conclusions.

2 The Integrated Evaluation Framework

Figure 1 presents the integrated evaluation framework developed in order to answer the research question previously elicited. The flowchart is divided into two main parts. Since the quality of open spaces deals with several spatial elements, a Spatial Multiple Criteria Decision Analysis (MCDA) has been firstly defined in order to combine spatial data provided through Geographical Information Systems (GIS) and decision maker's preferences into value maps, whereas in the second phase, the econometric model has been developed to estimate the marginal price of urban quality.

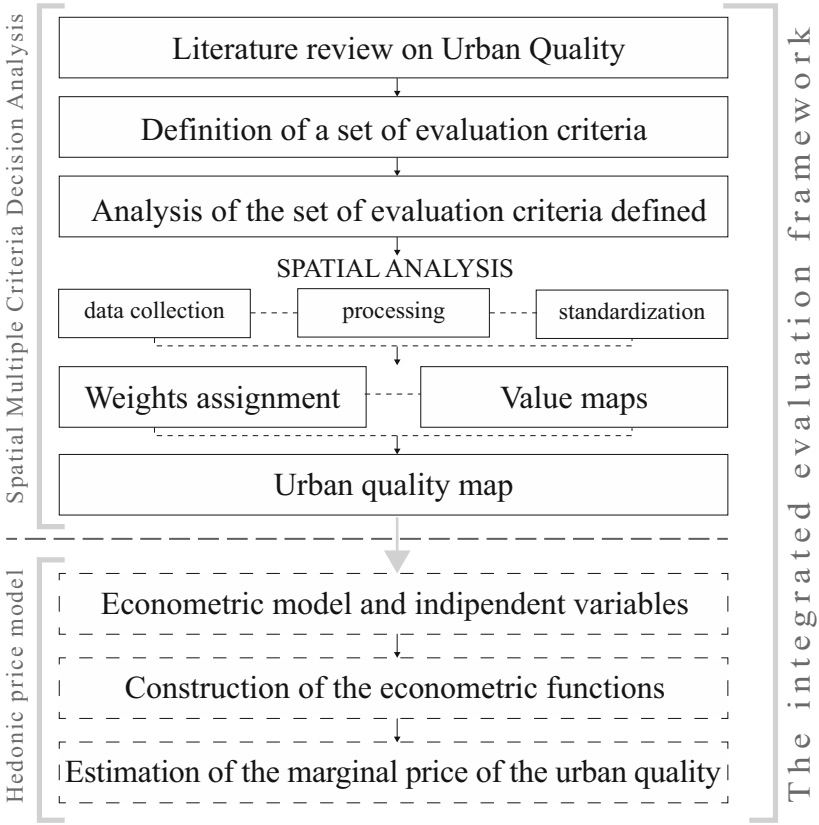

Fig. 1. The integrated evaluation framework

2.1 Spatial MCDA

The first phase of research has been carried on by focusing on the definition of urban quality through an in-depth literature review. As previously mentioned, it has been decided to conceive the urban quality by considering the definition given by the urban design approach meant as the study about the physical settings of the built environment, the morphological layout, consideration of intangible and visual values, the social context, etc. [11–14]. Once the urban quality has been defined, it has been possible to investigate its drivers in order to frame a set of criteria with the objective to measure the propensity of a place to generate urban quality. In this sense, given the hierarchical multi-attribute concept characterizing the urban quality, several attributes of a different nature have been considered. The literature review provided by Oppio et al. [7, 8] allowed to define a complete framework composed by three criteria, namely Accessibility, Supply of services and Public open spaces, divided into sub-criteria as presented in Fig. 2. For what concerns the five sub-criteria analyzed within the public open space dimensions, a total of twenty-six indicators have been further identified in order to better specify and measure their complexity.



Fig. 2. Set of criteria.

Considering the spatial nature of the criteria involved in the decision problem [15] and the results obtained by recent applications of MCDA method for the evaluation of urban quality [7, 8, 16–18] the use of Multi-Attribute Value Theory (MAVT) in the Geographic Information Systems (GIS) domain is proposed.

A compensative and additive model has been selected since a trade-off has to be defined among the dimensions and it is not possible to maximize all the aspects involved [19]. To this purpose, the MAVT has been adopted since it addresses problems with a finite set of alternative options evaluated with respect to conflicting objectives [20]. By combining the MAVT with the GIS domain, it is possible to clearly visualize the spatial relationships among strengths and weaknesses of the area under investigation [15], to organize and store a huge quantity of geographical data and to conduct operations directly useful for the decision process, inside a georeferenced environment [21]. Assumed the potentials previously pointed out, given the spatial nature of the problem and the multifaceted aspects to consider, a spatial MCDA model is proposed and divided into the traditional phases of a decision making process [22]:

1. Intelligence: it identifies the problem to be solved in order to frame a consistent set of criteria that allows understanding which kind of data has to be collected and which geo-operation has to be processed;
2. Design: it involves the standardization procedure and the weights' assignment;
3. Choice: it consists of data overlay, visualization of partial value maps and the overall urban quality map.

2.2 Hedonic Prices Method

To give an economic value to the urban quality indexes measured in the first phase of the analysis, we used the hedonic prices (HP) method based on Rosen's theory [10].

The HP method is based on the estimate of a multiple regression model in which the observed price of an asset is explained by the set of characteristics that describe it. In real estate, the price of buildings depends on intrinsic and structural features of the asset and extrinsic features related to the neighbourhood where it is located. In particular, the estimated coefficients explain the contribution, positive or negative, of each of the characteristics to the formation of the asset's market price. To obtain the hedonic price of each characteristic, it is necessary to identify a hedonic price function f which establishes a relationship between the price P of the good and all the characteristics that influence this value. This relationship can be schematized according to the Eq. (1), as follows:

$$y = f(x_1, x_2, \ldots, x_n) + e \tag{1}$$

where y is the dependent variable that represents the property price, x_i is the i-th independent variable that contributes to the formation of the value of the asset, e is the error term.

The HP method has been widely used to investigate the effects of urban quality on real estate prices. Glumac et al. [23], starting from a dataset of Luxembourg real estate transactions, investigated the relationship between quality improvements influence and the price of land. Boscacci et al. [24] valued the positive effects generated by the redevelopment of the Navigli area in Milan by a hedonic model. D'Acci [4] estimated the qualitative benefits perceived from the site's characteristics in Turin (Italy), focusing on the proximity to the centre and the increase in site quality. Rosato et al. [25] proposed a hybrid model based on HP method and Multi-Attribute Analysis to test the effects of the MOSE project (Electromechanical Experimental Module) for the protection of Venice (Italy) on real estate prices. Dell'Anna et al. [26] compared the effect of accessibility features on Turin and Barcelona property prices.

3 Case Study

The study area selected to apply the integrated evaluation framework previously defined is the city of Milan (Italy) and in detail three neighbourhoods located on the north-eastern side of the Municipality, from the centre to the administrative border (Fig. 3). The choice to measure the urban quality of neighbourhoods located on this diagonal axis is relevant since it allows to understand whether it differs from central to suburban areas. More, in detail:

- Brera is located in the city centre and is one of the most significant touristic spots in Milan. The area is mainly traffic-free and is easily accessible by public transports.
- Loreto is located at the border of the old city and is characterized by a high urban density. It is one of the most multi-ethnic districts of Milan, and in the last period, it has been populated with artists and young people.
- Adriano is located in the outskirt of the Municipality and is characterized by a not uniform urban shape. Nowadays it is at the centre of policies for its urban regeneration given its original character as a mainly residential district.

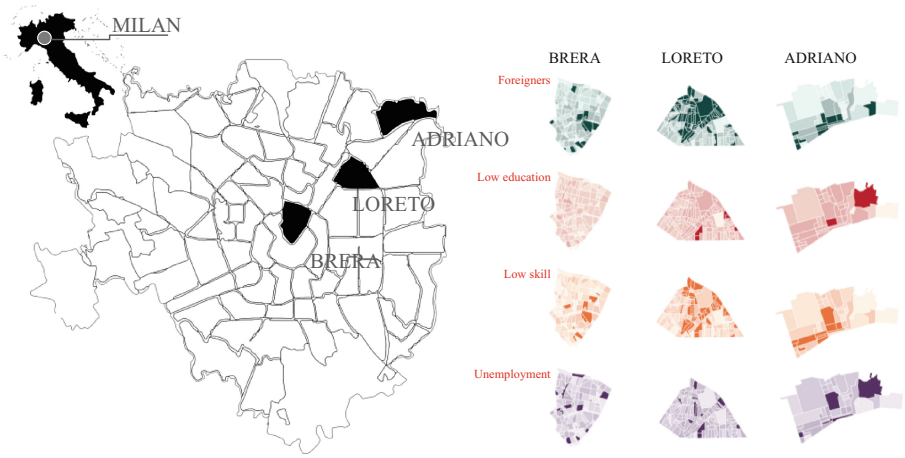

Fig. 3. Case study analyzed and social characteristics

The diagonal axis here described well represents three dissimilar neighbourhoods with different location features. Both Loreto and Adriano are undergoing significant changes for what concerns the population and urban fabrics.

The limit of each district has been identified according to the administrative division into Nuclei di Identità Locale (NIL, Centres of Local Identity) as the Municipality of Milan has defined them.

4 Application

Given the objective of the contribution to evaluate urban quality considering three main aspects, namely, the public open spaces quality, the accessibility and provision of services, multidimensional indicators have been defined either in the form of objective or subjective indicators.

Objective indicators are based on the attainment of various basic objectives of the product/service. In contrast, subjective indicators are employed more at the individual level and measure the individual's level of satisfaction with the product/service, that is, they represent a subjective perspective that lays on an introspective and personal experience-based concept.

The general objective of this study is related to the conceptualization of urban quality and to the investigation of an evaluation process able to standardize the evaluation of urban quality levels. This would ensure the replicability of the model, thus contributing to the optimization of the city performance.

4.1 Spatializing the Urban Quality

The spatial analysis has been developed by following the tree phases explained in Sect. 2.1. For what concerns the decision problem and the definition of an appropriate set of criteria it has already been described but what deserves to be better explored

is the process applied to detect and elaborate all the information necessary to obtain the partial value maps and the final overall urban quality map. Figure 4 presents all the stages performed aimed at resulting in the value maps.

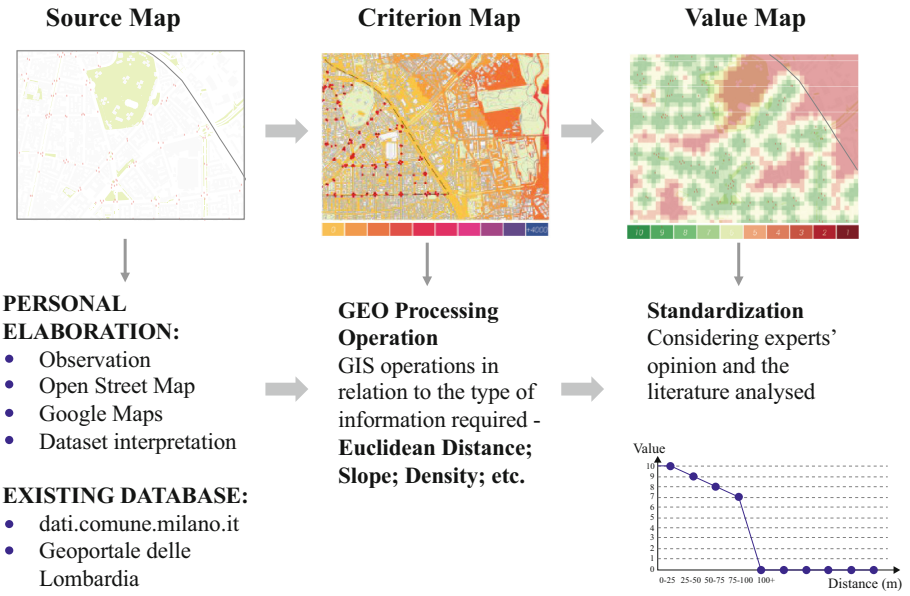

Fig. 4. Process to elaborate value maps

As already mentioned, the sub-criteria have been further measured by indicators, each requiring specific data that have been collected, mainly by the use of GIS maps developed by the Municipality of Milan and by other sources such as direct observation, Open Street Map and Google Maps (Source map). The work has been carried out with the support of the software ArcGIS and with the Spatial Analyst tool that allows performing the Spatial MCDA. The Geoprocessing operations have been carefully selected considering the information required and mainly two processes have been applied: the Euclidean Distance and the Density. The Criterion maps obtained and the information have been subsequently standardized by the support of experts and by analysing researches developed previously. The standardization procedure allowed to transform the unit of measurement of the selected sub-criteria in comparable units. According to the software used and to the geo-operation applied to the original data it is possible to assign a dimensionless score, from 0 to 10 (where 0 is the worst and 10 is the best score), to different performances considering how much they satisfy the specific requirement. The results of this phase are the Value maps where it is already possible to visualize the most suitable area in relation to the criterion or indicator investigated.

To aggregate the partial Value maps and result in the overall Urban quality map, the criteria weight elicitation has been performed. A focus group has been organized with 13 experts of different fields, asking to weight criteria considered and using the point allocation method. They decided to assign a different weight to the sub-criteria within

the Public open space criterion (Physical setting 33%, Connectivity 25%, Vitality 23%, Meaning 13%, Protection 16%), The same weight has been attributed to the sub-criteria belonging to Accessibility and Supply of Services. To visualize a neutral scenario, the three criteria have been considered with the same importance.

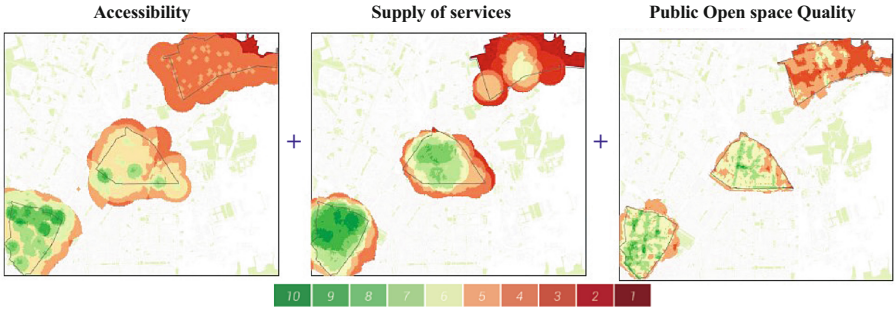

Fig. 5. Partial Value maps

Once the weights' assignment has been performed, it is possible to proceed with the aggregation of the sub-criteria, to visualize the partial value maps of the criteria involved (Fig. 5) and finally by aggregating them to visualize the overall Urban quality map (Fig. 6). The aggregation has been carried on considering the MAVT explained previously.

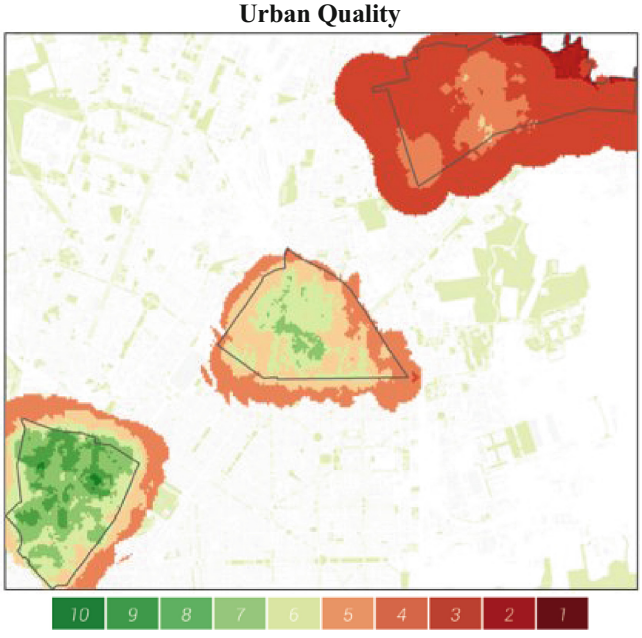

Fig. 6. Overall Urban quality map

From both the partial maps and the overall, it is evident the predominance of cells with high value in the city core while moving toward the suburb, the value tends to decrease.

4.2 Estimating the Urban Quality

Collected around 350 offering prices for dwellings located in the three urban districts considered in this application, the HP model was implemented with the aim to estimate the coefficients of the urban quality variables. The data refer to advertisements of apartments located in condominiums published in 2018 by the online real estate agency www.immobiliare.it. We reduced the dataset to 338 observations after eliminating the outliers responsible for distorting the results of the hedonic model.

From the real estate agency ads, seven main variables were identified (Table 1):

Table 1. Descriptive statistics of variables (338 observations)

Variables	Measure	Min	Max	Mean	SD
Asking price (€)	Scale	59,000	2,800,000	505,201	500,261
Floor area (m^2)	Scale	25	300	96.95	49.56
Number of bathrooms	Scale	1	3	1.45	0.62
Dwelling's level	Scale	0	11	2.48	2.08
Energy class	Scale	1	5	1.61	1.043
State of conservation	Ordinal	1	4	2.63	0.77
Year range	Ordinal	1	8	4.10	2.149
Accessibility	Ordinal	2	8	4.49	1.88
Supply of services	Ordinal	0	8	4.56	2.07
Open spaces	Ordinal	1	4	2.63	0.59
Urban quality	Ordinal	1	6	3.57	1.434

- Asking price (dependent variable) is the price recommended by the real estate agent for the property, expressed in euro (€).
- Floor area, which indicates the commercial area and includes the internal walls, the perimeter walls, half of the walls bordering other properties or condominiums, half of the balconies, 1/3 of the terraces, 1/5 of the terraces on the upper floor, expressed in m^2.
- Number of bathrooms counts the bathrooms in the apartment.
- Dwelling's level indicates the level of the floor where the property is located in the condo, where the ground floor and mezzanine floor is equal to 0, the first floor is worth 1, and so on.

- Energy class indicates the energy performance of the property, and it is based on the Energy Performance Certificate (EPC) promoted in 2010 by the European Directive EPBD 2010/31/EU. According to EPC, 1 indicates a property in class G, 2 in class F, and so on [27].
- State of conservation specifies the maintenance status of the dwelling (1 = Poor/To be restored; 2 = Good; 3 = Restored; 4 = New/Under construction) [28].
- Year range variable clusters the properties according to the age class of construction of the buildings where they are located (before 1900 = 1, 1901–1920 = 2, 1921–1945 = 3, 1946–1960 = 4, 1961–1975 = 5, 1976–1990 = 6, 1991–2005 = 7, after 2005 = 8) [29].

We implemented the offer price dataset with the disaggregated urban quality (Accessibility, Supply of services, Public Open space Quality) variables, and their aggregated value (Urban Quality), according to properties' location, in order to measure the spillover effect of housing prices.

Before carrying out hedonic regressions, a correlation test of the dataset variables was carried out (Table 2). If a multivariate linear regression function specifies the hedonic price function, the explanatory variables should be hypothetically independent of each other. Otherwise, multicollinearity between independent variables is present. The validity of the regression model cannot be separated from the choice of explanatory variables to be included in the calculation, which must influence the formulation of the price. In detail, Pearson's test showed that a strong correlation exists between the floor area and the number of bathrooms, as expected. The calculation of the correlation index highlighted the presence of collinearity between urban quality variables.

Furthermore, the State of conservation is correlated both with the Energy class and the year of construction, as foreseeable. Besides, the urban quality variables are strongly correlated with the Year range and Energy class variables. Starting from the hypothesis that real estate developments have followed the urban dynamics of the city of Milan, these last characteristics are uniformly distributed in the neighbourhoods. Given the results of the collinearity test, some variables have not been included in the model. In the presence of this phenomenon, the equation used may not be significant and produce distorting effects in the results of the estimate. Consequently, it was decided to comprise the aggregated Urban Quality (UQ) variable and to discard the Year range and Energy class as predictors.

5 Discussion of the Results

The HP theory does not indicate the perfect function type to adopt in the regression model. Rosen claimed that the function is rarely linear. This situation occurs only when the property is a perfectly divisible asset. The most frequently used regression functions are the semi-logarithmic and logarithmic forms. In the case of the semi-logarithmic form, the coefficient can be interpreted as the percentage variation of the property's price following an extra-unit of the independent characteristic. Two different regression models based on Ordinary Least Square (OLS) have been applied considering "Offering price" as the dependent variable in logarithmic scale (LN Price).

Table 2. Correlation analysis

		Floor area	Number of bathrooms	Dwelling's level	Energy class	State of conservation	Year range	Accessibility	Supply of services	Open spaces	Urban quality
Floor area	Pearson corr.	1	.743**	.114*	.026	-.057	-.039	.325**	.227**	.198**	.298**
	Sign.		.000	.037	.638	.294	.471	.000	.000	.000	.000
Number of bathrooms	Pearson corr.	.743**	1	.105	.214**	.084	.063	.258**	.188**	.189**	.260**
	Sign.	.000		.054	.000	.124	.245	.000	.001	.000	.000
Dwelling's level	Pearson corr.	.114*	.105	1	.156**	.024	.129*	.014	-.072	-.037	-.040
	Sign.	.037	.054		.004	.665	.018	.792	.188	.503	.465
Energy class	Pearson corr.	.026	.214**	.156**	1	.430**	.472**	-.151**	-.202**	-.028	-.172**
	Sign.	.638	.000	.004		.000	.000	.005	.000	.611	.001
State of conservation	Pearson corr.	-.057	.084	.024	.430**	1	.300**	.028	-.057	-.076	-.022
	Sign.	.294	.124	.665	.000		.000	.611	.299	.163	.693
Year range	Pearson corr.	-.039	.063	.129*	.472**	.300**	1	-.401**	-.425**	-.299**	-.435**
	Sign.	.471	.245	.018	.000	.000		.000	.000	.000	.000
Accessibiliy	Pearson corr.	.325**	.258**	.014	-.151**	.028	-.401**	1	.736**	.550**	.900**
	Sign.	.000	.000	.792	.005	.611	.000		.000	.000	.000
Supply of services	Pearson corr.	.227**	.188**	-.072	-.202**	-.057	-.425**	.736**	1	.659**	.917**
	Sign.	.000	.001	.188	.000	.299	.000	.000		.000	.000
Open spaces	Pearson corr.	.198**	.189**	-.037	-.028	-.076	-.299**	.550**	.659**	1	.719**
	Sign.	.000	.000	.503	.611	.163	.000	.000	.000		.000
Urban quality	Pearson corr.	.298**	.260**	-.040	-.172**	-.022	-.435**	.900**	.917**	.719**	1
	Sign.	.000	.000	.465	.001	.693	.000	.000	.000	.000	

** = significant at 0.01
* = significant at 0.05

Table 3 shows the results of the semi-log model computed via OLS estimator, introducing as an independent variable the UQ in the ordinal scale, from the worst level (UQ 1) to the best (UQ 6). In the first model, the coefficients of the variables have obtained the expected sign. The four explanatory variables identified above are statistically significant and show adequate amounts and signs. From these results, it is possible to deduce the marginal percentage value of the predictors. The size of the apartment (Floor area variable) positively affects the price of the properties ($\beta = 0.01$). Referring to the Dwelling's level variable, it is possible to deduce that living on a high floor is seen as an advantage, influencing the property price by 4.6% for each additional floor. The state of conservation strongly affects the price ($\beta = 0.151$). The UQ seems to be the characteristic that most influences the price of the properties, with a percentage of 27.6%. It is not surprising that this variable significantly affects the market price, as it represents the extrinsic characteristics relating to the urban belt, the neighbourhood, the accessibility of the area where a property is located, and the services available. This result agrees with the literature, which emphasizes that these positional characteristics can influence the price of properties from 15% to 35% [30].

Table 3. Regression model results – Nonlinear model (OLS)

	Non-standardized coefficients		t	Sign.
	β	SE		
Constant	10.310	0.100	102.601	0.000
Floor area	0.010	0.000	21.787	0.000
Dwelling's level	0.046	0.010	4.481	0.000
State of conservation	0.151	0.028	5.472	0.000
Urban quality	0.276	0.016	17.744	0.000
LN Price (mean)	R^2	Adjusted R^2	SE of estimate	
12.764	0.781	0.778	0.39	

The second regression model wants to check if UQ levels can affect real estate asset differently. For this reason, the UQ variable has been discretized in dichotomous variables, one for each level. UQ level 6 has been excluded from the hedonic model in order to verify the potential benefits generated by the minimum requirements of UQ in terms of population appreciation. In fact, from a political point of view, urban quality is undoubtedly one of the decisive elements in improving the perception of safety and wellbeing among the inhabitants [31]. If then the interventions in the booming part of the city of Milan have a strong significance linked to tourism promotion, the actions of public policies in the most degraded areas assume fundamental importance in improving the quality of life. With this in mind, ensuring interventions to improve urban quality is one

of the fundamental tasks of the Public Administration. Table 4 shows the results of the second hedonic model. By comparing the performance parameters of the two models, it is possible to confirm that the second model explains more significant deviance between observed and fitted values (Adjusted $R^2 = 0.806$). The explanatory variables assume statistical significance and congruous signs. By focusing on the variables of the UQ levels, it is possible to confirm that an appreciation exists with respect to the UQ levels 1, 2, 3 and 4. Compared to the UQ level 5, the consumer is no longer willing to pay for higher UQ levels. According to the decreasing marginal utility theory, once the maximum utility level represented by the UQ level 5 is reached, any other increases will probably bring disutility, decreasing the level of individual satisfaction. These results confirm that an appreciation for the characteristics considered in the UQ index exists and it is reflected in the real estate market of the city of Milan. From the results, a real estate unit can double its market price if it is located in an area characterized by a high level of urban quality (beta coefficient of UQ level 1 = 1.00).

Table 4. Regression model results – Nonlinear model (OLS)

	Non-standardized coefficients		t	Sign.
	β	SE		
Constant	11.803	0.120	98.174	0.000
Floor area	0.010	0.000	23.473	0.000
Dwelling's level	0.041	0.010	4.101	0.000
State of conservation	0.132	0.026	5.025	0.000
Urban quality level 1	−1.000	0.101	−9.928	0.000
Urban quality level 2	−0.910	0.086	−10.598	0.000
Urban quality level 3	−0.744	0.083	−8.934	0.000
Urban quality level 4	−0.413	0.081	−5.105	0.000
Urban quality level 5	0.156	0.081	1.918	0.056
LN Price (mean)	R^2	Adjusted R^2	SE of estimate	
12.764	0.810	0.806	0.364	

6 Conclusions

The methodology proposed within this contribution and applied to three different neighbourhoods in the Municipality of Milan aimed at assessing the value of the urban quality, both considering monetary and non-monetary methodologies.

One of the strengths of the methodological approach adopted can be detected, in fact, in the combination of qualitative and quantitative methodologies which allows on one side to catch the drivers of urban quality and on the other to assess them accurately. One of the possible outcomes of the study could be supporting policies concerning urban regeneration and planning. By making the monetary value of urban quality explicit, Public Administration, investors, developers and urban designers can easily consider the economic impact of their choices when designing cities and neighbourhoods. For example, the results obtained lead to reflect on the economic effects generated by urban transformations, in particular of areas with low quality of public and private services. In the case study, the main problems have been detected in the Adriano district, which is attributable to that part of the city which grew up around the 90s without a global vision but somewhat disconnected and unfinished. In this kind of areas, the neighbourhood scale approach is almost impossible and insufficient. For this reason, supported by the analysis provided and the value maps, it is clear how punctual interventions are not enough and should be accompanied in some way by different actions based on a strategy that operates through the urban context.

Another outcome of the research is the definition of a synthetic index able to represent features about extrinsic characteristics of the neighbourhood and as a result, to improve information into the real estate market. This notion can become strategic in decision-making processes regarding urban development where the private sector is involved and moreover in public-private negotiations to understand the benefits produced by a higher level of urban quality.

At the same time, some limits are present, and other aspects should be deepened.

The datasets of observation should be expanded in order to validate better the results obtained and provide more robust conclusions. A higher number of observations could allow to describe better the incidence of the three variables (Accessibility, Supply of Services and Public Open Space Quality) in achieving the urban quality and evaluate their marginal price.

Finally, future studies could be related to the development of a Choice-Experiment to calculate consumers' willingness to pay for the different characteristics of the urban quality and to compare the results with those obtained by performing the HP model. In fact, according to Louviere et al. [32], an approach that integrates Revealed Preferences (RPs) and Stated Preferences (SPs) approaches can limit the errors of the unobserved variables that characterize RPs.

References

1. United Nations Department of Economic and Social Affairs: 68% of the world population projected to live in urban areas by 2050, says UN. https://www.pc.gov.au/research/supporting/non-market-valuation

2. Weziak-Białowolska, D.: Quality of life in cities - empirical evidence in comparative European perspective. Cities **58**, 87–96 (2016). https://doi.org/10.1016/j.cities.2016.05.016
3. Carmona, M.: Place value: place quality and its impact on health, social, economic and environmental outcomes. J. Urban Des. **24**, 1–48 (2019). https://doi.org/10.1080/13574809.2018.1472523
4. D'Acci, L.: Quality of urban area, distance from city centre, and housing value. Case study on real estate values in Turin. Cities **91**, 71–92 (2019). https://doi.org/10.1016/j.cities.2018.11.008
5. Simonotti, M.: La stima immobiliare. UTET, Turin (1997)
6. D'Acci, L.: Monetary, subjective and quantitative approaches to assess urban quality of life and pleasantness in cities (hedonic price, willingness-to-pay, positional value, life satisfaction, isobenefit lines). Soc. Indic. Res. **115**(2), 531–559 (2013). https://doi.org/10.1007/s11205-012-0221-7
7. Oppio, A., Bottero, M., Arcidiacono, A.: Assessing urban quality: a proposal for a MCDA evaluation framework. Annal. Oper. Res. 1–18 (2018). https://doi.org/10.1007/s10479-017-2738-2
8. Oppio, A., Bottero, M., Giordano, G., Arcidiacono, A.: A multi-methodological evaluation approach for assessing the impact of neighbourhood quality on public health. Epidemiologia e Prevenzione **40**, 249–256 (2016). https://doi.org/10.19191/EP16.3-4.P249.092
9. Montibeller, G., Franco, A.: Decision and risk analysis for the evaluation of strategic options. In: O'Brien, F.A., Dyson, R.G. (eds.) Supporting Strategy: Frameworks, Methods and Models, pp. 251–284. Wiley, West Sussex (2007)
10. Rosen, S.: Hedonic prices and implicit markets: product differentiation in pure competition. J. Polit. Econ. **82**, 34–55 (1974). https://doi.org/10.1086/260169
11. Punter, J.: Developing urban design as public policy: best practice principles for design review and development management. J. Urban Des. **12**, 167–202 (2007). https://doi.org/10.1080/13574800701306195
12. Carmona, M., Heath, T., Tiesdell, S., Oc, T.: Urban design today. In: Public Places Urban Spaces, pp. 3–19 (2010)
13. Dias, N., Curwell, S., Bichard, E.: The current approach of urban design, its implications for sustainable urban development. Procedia Econ. Financ. **18**, 497–504 (2014). https://doi.org/10.1016/s2212-5671(14)00968-x
14. Urban Design Group: What is Urban Design? http://www.udg.org.uk/about/what-is-urban-design
15. Dell'Ovo, M., Capolongo, S., Oppio, A.: Combining spatial analysis with MCDA for the siting of healthcare facilities. Land Use Policy **76**, 634–644 (2018). https://doi.org/10.1016/j.landusepol.2018.02.044
16. Munda, G.: Measuring sustainability: a multi-criterion framework. Environ. Dev. Sustain. **7**, 117–134 (2005). https://doi.org/10.1007/s10668-003-4713-0
17. Blečić, I., Cecchini, A., Congiu, T., Fancello, G., Trunfio, G.A.: Evaluating walkability: a capability-wise planning and design support system. Int. J. Geogr. Inf. Sci. **29**, 1350–1374 (2015). https://doi.org/10.1080/13658816.2015.1026824
18. Nijkamp, P., Teresa, M., Ciuffo, B., Torrieri, F.: Sustainable urban land use and transportation planning: a cognitive decision support system for the Naples metropolitan area. Int. J. Sustain. Transp. **1**, 91–114 (2007). https://doi.org/10.1080/15568310601091981
19. Dell'Ovo, M., Oppio, A.: Bringing the value-focused thinking approach to urban development and design processes: the case of foz do tua area in Portugal. Valori e Valutazioni **23**, 91–106 (2019)
20. Keeney, R.L., Raiffa, H.: Decision Making with Multiple Objectives Preferences and Value Tradeoffs, New York (1976)

21. Malczewski, J.: GIS-based multicriteria decision analysis: a survey of the literature. Int. J. Geogr. Inf. Sci. **20**, 703–726 (2006). https://doi.org/10.1080/13658810600661508
22. Simon, H.A.: Theories of bounded rationality. In: McGuire, C.B., Radner, R. (eds.) Decision and Organization. North-Holland Pub. Co., Amsterdam (1972)
23. Glumac, B., Herrera-Gomez, M., Licheron, J.: A hedonic urban land price index. Land Use Policy **81**, 802–812 (2019). https://doi.org/10.1016/j.landusepol.2018.11.032
24. Boscacci, F., Camagni, R., Caragliu, A., Maltese, I., Mariotti, I.: Collective benefits of an urban transformation: Restoring the Navigli in Milan. Cities **71**, 11–18 (2017). https://doi.org/10.1016/j.cities.2017.06.018
25. Rosato, P., Breil, M., Giupponi, C., Berto, R.: Assessing the impact of urban improvement on housing values: a hedonic pricing and multi-attribute analysis model for the historic centre of Venice. Buildings **7**, 112 (2017). https://doi.org/10.3390/buildings7040112
26. Dell'Anna, F., Bravi, M., Marmolejo-Duarte, C., Bottero, M.C., Chen, A.: EPC green premium in two different European climate zones: a comparative study between Barcelona and Turin. Sustain. (Switzerland) **11**, 5605 (2019). https://doi.org/10.3390/su11205605
27. European Commission: Directive 2010/31/UE, Energy Performance of Building Directive Recast (EPBD recast). https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32010L0031&from=it
28. Bottero, M., Bravi, M., Dell'Anna, F., Mondini, G.: Valuing building energy efficiency through Hedonic Prices Method: are spatial effects relevant? Valori e Valutazioni **21**, 27–40 (2018)
29. Ballarini, I., Corgnati, S.P., Corrado, V.: Use of reference buildings to assess the energy saving potentials of the residential building stock: the experience of TABULA project. Energy Policy **68**, 273–284 (2014). https://doi.org/10.1016/j.enpol.2014.01.027
30. Forte, C., De' Rossi, B.: Principi di economia ed estimo. Etas libri (1979)
31. Gabrielli, L., Giuffrida, S., Trovato, M.R.: From surface to core: a multi-layer approach for the real estate market analysis of a central area in Catania. In: Gervasi, O., Murgante, B., Misra, S., Gavrilova, M.L., Rocha, A.M.A.C., Torre, C., Taniar, D., Apduhan, B.O. (eds.) ICCSA 2015. LNCS, vol. 9157, pp. 284–300. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-21470-2_20
32. Louviere, J.J., Hensher, D.A., Swait, J.D.: Combining sources of preference data. In: Stated Choice Methods. pp. 227–251. Cambridge University Press (2000)