An Integrated Methodological Framework for Urban Well-Being Assessment: An Application to the City of Siracusa (Italy)

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Abstract. In recent years, the concept of urban well-being and quality of life has emerged as a central theme for the planning agenda. Orienting urban planning toward enhancing urban well-being, while properly considering its complexity stemming from its multi-dimensional nature, calls for appropriate knowledge bases and assessment tools to support decisions on actions toward urban livability. Based on these premises, the paper proposes an integrated methodological framework for urban well-being assessment, which leads to the definition of an Urban Well-Being (UWB) composite indicator. The proposed framework integrates a "quantitative" and "data-based" approach with a "qualitative" and "perception-based" one, thus overcoming the mere data-based approach to the theme and providing a comprehensive assessment of well-being and its distribution mechanisms within an urban area. The framework's preliminary application to Syracuse - a mid-sized city in the Sicily Region (Italy) – demonstrates its potential as a decision support tool, together with its limits and future research challenges to effectively orient urban policies towards greater equity, awareness, and quality of life.

Keywords: Methodological framework · Urban · Well-being · Assessment · Planning

1 Introduction

In recent years, the concept of urban well-being and quality of life has emerged as a central theme for the planning agenda [1, 2]. The growing attention towards the livability of urban spaces reflects the awareness that the progress of a city cannot be merely measured in terms of economic or physical development but must consider the overall well-being of resident citizens [3, 4]. From this perspective, the quality of urban life emerges as a complex theme, influenced by the interweaving of different dimensions: accessibility to services and daily opportunities, environmental conditions, safety and health, infrastructural facilities, social cohesion, and the equity in the distribution of rights and opportunities [5]. The COVID-19 pandemic has amplified the debate on the importance of living in healthy, well-served, and human-scale urban environments [6].

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Therefore, the academic and planning debate has paid growing attention to metrics and tools to support the integrated assessment of urban well-being [7]. Resting on the recognition of the inadequacy of traditional economic indicators (i.e., the GDP) in capturing the multi-dimensional nature of well-being [3], different institutional initiatives have dealt with alternative approaches for urban well-being assessment. In Italy, initiatives such as the BES (Equitable and Sustainable Well-being) [8, 9] or the annual rankings of provinces, based on their quality of life, reflect the need to meet the demand for assessment tools and indicators to measure urban well-being [10]. These assessment tools, properly considering the multi-dimensional nature of urban well-being and the specificities of different urban environments, can offer a valuable contribution to the design of policy oriented to urban livability.

Based on these premises, the paper aims to provide an integrated methodological framework to assess well-being at the urban level, thus providing a robust knowledge ground to support "catered" urban planning decisions geared towards promoting justice and livability in cities. Specifically, by integrating an objective, data-driven component with a subject, perception-based one, the proposed assessment framework not only enables a multi-dimensional assessment of the distribution of well-being at the urban scale, but also provides some hints about the experiential dimension of access to services.

The paper moves from providing an overview of the theoretical planning models geared toward triggering urban quality of life and well-being, together with their critical issues in Sect. 2. Starting from a systematic literature review process about urban well-being assessment, Sect. 3 proposes an integrated methodological framework for the definition of an urban well-being composite indicator. Section 4 presents the application of the proposed framework to a case study - the city of Syracuse in the Sicily Region (Italy) – and its results in terms of distribution of urban well-being.

In Sect. 5, these results are assumed as the basis to discuss the opportunities, limits, and future research efforts related to implementing and spreading the proposed methodological framework as a decision-support tool for social equity in urban planning.

2 Urban Well-Being: Conceptual and Planning Foundations

The concept of well-being has accompanied human reflection since ancient times and, over the centuries, has progressively transformed from a philosophical ideal to a multidimensional construct used in social sciences and public policies [11]. In classical philosophies, two main orientations are distinguished: a hedonistic vision of "good living", centred on pleasure and the reduction of pain, and a eudaimonic vision, which interprets happiness as personal fulfilment and virtuous life. With modern utilitarianism, this concept also assumes a collective dimension: the idea of maximizing happiness for the greatest number of people introduces a criterion of social evaluation that anticipates, in embryonic form, future aggregate measures of well-being [3].

In the twentieth century, and in the post-war period, the concept was further consolidated and entered institutional definitions. A decisive step, in this sense, is the definition of health adopted by the World Health Organization in 1946, which identifies it in the state of complete physical, mental, and social well-being, rather than in the simple absence of disease [12]. This definition shifts the focus towards a positive and integrated

conception of living conditions, highlighting that "being well" depends on the intertwining of bodily, psychological, and relational dimensions. In recent decades, research has further expanded this framework, placing increasing attention on subjective well-being. Psychological and economic studies have shown that increasing income, beyond a certain threshold, does not automatically translate into an increase in declared happiness [13], thus stimulating new investigations on life satisfaction and the quality of daily experience. Positive psychology, which developed in the early 2000s, has strengthened this orientation, shifting the focus to factors such as resilience, optimism, and personal fulfilment [11]. However, the interdisciplinary expansion of the concept has brought along the difficulty of defining it unequivocally: well-being is recognized as a multidimensional concept, but, consequently, each discipline has proposed different readings and metrics for it [11].

Coming to the urban dimension of well-being, the growth of urbanization in the 20th and 21st centuries has made it increasingly clear that cities are not only places of opportunity, but also environments that produce pressures and vulnerabilities: high density, traffic, pollution, noise, lack of space, socio-spatial imbalances, and unequal access to resources. Since the 1970s, studies in environmental psychology and urban planning have analysed the impact of the built environment on the quality of life, showing how housing overcrowding and poor availability of green space can increase stress and reduce life satisfaction. On the contrary, pedestrian areas, public green spaces, and spatial opportunities for social interaction are recognized as generating positive relationships and psychophysical health [14]. Such a recognition paves the way for an integrated approach to the challenge of promoting urban well-being, which acts both on the physical dimension of cities (i.e., by improving air quality, accessibility to services, safety, mobility) and on residents' perception sphere (i.e., by strengthening their perception of safety, sense of community, attachment to places) [1].

By embracing this perspective, urban well-being can be understood as the city's ability to offer healthy, safe, stimulating, and inclusive living conditions, considering both physical morphologies and social processes that affect residents' life patterns. Consequently, urban well-being can only stem from striking a balance between environmental, social, and economic factors, while facilitating citizens' participation and sense of belonging.

The recognition of the link between urban space and well-being has led the planning debate to develop theoretical reference models to be implemented towards more liveable, inclusive, and just cities. Among these, three paradigms emerge as particularly relevant: the "15-min city", the "City of needs", and the "Just City" (see Table 1). While proposing different accents, they converge on the idea that urban planning must assume well-being and spatial justice as explicit objectives.

The "15-min city", promoted by Carlos Moreno, proposes a polycentric and proximity reorganization, in which most of the daily functions are accessible on foot or by bicycle in a short time [10]. Given its dual attention to individual well-being and collective welfare, this model is at the center of the international urban planning debate on the future of metropolitan areas [15].

According to it, travel time is not only a functional objective, but a lever of quality of life: it reduces stress, gives back time, strengthens local sociality, and reduces dependence on the car, with environmental benefits. The model is based on some recurring design dimensions: adequate density, short distance, functional and social diversity, and the integration of services and technologies that reduce the need for travel. From this perspective, proximity becomes a resource of well-being if it is pursued with attention to equity between neighbourhoods. However, its implementation requires addressing different challenges: it requires integrated planning, investments in soft mobility, and a cultural change in lifestyle habits.

The paradigm of the "City of needs", instead, has emerged in the academic and political debate as a critical counterpoint to the neoliberal city oriented towards markets and consumption. Several scholars have focused on the need to ground planning decisions on the real needs of the inhabitants, especially the weakest social groups [16]. The starting point for this model implementation is identifying fundamental needs: living with dignity, working with stability, accessing essential services, living in healthy neighbourhoods equipped with spaces for social interaction, and feeling safe and recognized. The model calls for planning to become an instrument of care and rebalancing, especially in territories affected by precariousness and marginality. Mapping social and territorial needs, thus, becomes an operational precondition for targeted interventions: understanding where health facilities, schools, public transport, and civic spaces are lacking; recognizing housing conditions and unexpressed needs; activating participatory processes to offer context-specific planning responses. In this sense, well-being is not read as an abstract urban metric, but as the city's ability to reduce discomfort and inequalities, promoting empowerment and cohesion.

The "Just City", theorized by the American political scientist and urban planner Susan S. Fainstein in her book "The Just City" (2010), proposes a normative-evaluative framework that makes the main objective of planning [5]. From this perspective, a city can be said to be "just" if it pursues equitable outcomes in the distribution of resources and opportunities, ensures democratic decision-making processes, and recognizes diversity as an urban value. Three principles constitute the normative core of the "Just City": equity, democracy, and diversity. Equity indicates a more equitable distribution of resources, services, and benefits of urban life among all social groups. Democracy is intended as the possibility for citizens to control their living environment. Finally, a "Just City" encourages and maintains urban diversity, understood both as socio-economic and ethnic mixing in neighbourhoods, and as a variety of uses and urban environments. However, these principles are not always convergent: a participatory process can produce localistic and unequitable outcomes, while diversity policies can trigger dynamics of exclusion or social replacement. For this reason, equity assumes a priority role, since well-being should not be evaluated as an average, but also in terms of distribution, by carefully recognizing who benefits from urban advantages, who remains excluded, and the contribution of spaces to reproducing or mitigating inequalities.

The resulting challenge for architects, urban planners, and policymakers, stemming from the willingness to implement these three paradigms in urban planning, lies in translating these principles into effective and integrated actions able to consider and properly balance the multiple interests and objectives at stake.

Table 1. Comparison of three urban models addressing well-being and spatial justice (Authors' elaboration)

Model	View of well-being	Planning logic
15-min city	Proximity to daily services	Polycentric and adaptive, focused on proximity
City of needs	Improving living conditions for disadvantages groups	Inclusive and participatory, centered on urban fragilities
Just city	Fair distribution of resources and social inclusion	Normative, oriented toward substantively just outcomes

Addressing this challenge requires building up solid knowledge bases, enabling the capture of the complexity of urban well-being, thus calling for the definition of integrated and context-sensitive assessment tools.

3 Assessing Urban Well-Being: An Integrated Methodological Framework

3.1 Investigating Evaluation Approaches to Urban Well-Being: A Systematic Literature Review

The willingness to orient planning efforts toward promoting well-being and quality of life in urban areas by recognizing its multi-dimensional and complex nature calls for a sound knowledge base and appropriate methodological support to build it.

From this perspective, the paper proposes an integrated methodological framework to assess well-being at the urban scale, while focusing on its distribution mechanisms across different areas.

Building up such an integrated methodological framework requires analysing the landscape of existing scientific literature on urban well-being assessment. To this aim, the framework construction rests on a systematic literature review, conducted through the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol [17]. The choice to adopt this protocol meets the need to ensure traceability and transparency in the literature review process, avoiding subjective biases in the selection of scientific sources.

The application of the PRISMA protocol required, as the initial phase, the identification of the preliminary set of scientific sources to be reviewed. The bibliographic research was carried out by keywords on the Scopus scientific database and the Google Scholar search engine. The keywords string used is: "urban well-being" OR "urban well being" OR "urban wellbeing" AND "assessment" OR "evaluation" OR "index" AND "Quality of life" OR "Life quality" on Scopus; "urban well-being", "index", "quality of life" on Google Scholar. This preliminary step led to the identification of 82 sources as potentially relevant. It should be noted that, in this phase, no rigid limit was placed on publication time to include both recent research and seminal studies in the field.

However, most of the articles identified have been published in the last fifteen years, revealing a growing recent interest in the urban well-being theme.

Of the 82 articles, 4 were duplicates and were eliminated. The remaining 78 were subjected to a screening phase, based on reading the title and abstract. During this phase, 63 articles were excluded, as they not directly address the topic of urban well-being assessment. Indeed, many of the excluded papers focus on "specific" topics such as the presence of urban green, environmental sustainability of buildings, improvement of the living conditions for elderly people, or on general theoretical approaches, without proposing an operational framework for measuring urban well-being.

At the end of the screening phase, 15 articles were selected and subjected to a subsequent phase of suitability assessment based on their full-text reading. In this phase, 5 articles were excluded for three main reasons: impossibility of accessing the full-text; significant methodological overlap with other studies already included; lack of an in-depth discussion about an assessment framework.

The final corpus, consisting of 10 papers, therefore, represents the set of the most relevant scientific contributions for the research purposes. These papers were analysed to understand: their methodological ground for the assessment task, the reference metrics or dimensions for the evaluation, and their fields of application (see Table 2).

The comparative analysis of the selected studies, despite their differences in terms of case study location and methodological approach, returns some recurring reference dimensions for the assessment of urban well-being:

- The environmental dimension is considered in almost all studies, both in terms of environmental physical quality (pollution, green spaces, environmental services), and as ecological sustainability measured through indicators of resource consumption and emissions [20, 27].
- Health and safety are further cornerstones, often accompanied by measures related to access to health services and personal protection [27].
- A central role is played by the socio-economic dimension, with indicators relating to income, employment, and material living conditions [23].
- Housing conditions, transport opportunities, and accessibility to urban services also recur as relevant dimensions, together with relational and community aspects, such as civic participation, social cohesion, and interpersonal trust [20]. Several studies also include the cultural dimension and leisure, revealing a broad interpretation of the urban well-being concept [26].

From a methodological point of view, a convergence towards structured multidimensional approaches is observed, often inspired by consolidated frameworks such as the Better Life Index [9], and towards the use of composite indices to synthesize the different dimensions [21]. Integration of objective indicators and subjective measures of satisfaction is also widespread, recognizing that urban well-being cannot be captured solely through measurable data nor only through individual perceptions [18, 27].

Overall, the analyzed corpus of literature confirms the multidimensional nature of urban well-being and the need for assessment tools capable of combining methodological solidity, comparability, and attention to the specificities of the addressed urban environment.

Table 2. Relevant studies addressing urban well-being assessment (Authors' elaboration)

Authors (Year)	Ref	Methodological ground	Relevant metrics/dimensions
Das (2008)	[18]	Survey-based empirical study; objective + subjective QOL; factor analysis; reliability test (Cronobach's alpha)	27 objective variables (physical, economic, social conditions); Subjective satisfaction on same domains (Likert 5); overall QOL question (pre/post)
Schleicher (2021)	[19]	Mixed methods; participatory adaptation of OECD Better Life Index (BLI); Workshop (qualitative coding) + citizen survey; descriptivist stats + regression	12 priority dimensions (income, jobs, housing, infrastructure, safety, culture, education, environment, health, civic participation, community, subjective satisfaction)
Stern & Kissinger (2025)	[20]	Comparative multi perspective framework ("three-legs"); secondary quantitative data; rankings + standardisation (0–100); domain averages	3 thematic dimensions: (i) conventional (income, education, health, etc.); (ii) integrated (social/cultural/environmental + SDGs/BLI/CIW-type domains); (iii) socio-environmental (strong sustainability)
Sarra & Nissi (2020)	[21]	Spatial composite indicator; BES-based dataset; geographically weighted PCA + DEA-BoD for endogenous weights; index normalised	11 well-being dimensions + 64 indicators (UR-BES): human + ecosystem well-being (health, education, environment quality, work, safety, social relations, leisure, landscape heritage)
Hadj Kilani (2022)	[22]	Critical review of selected studies (secondary review); comparison of quantitative, qualitative, and mixed approaches	Recurring dimensions across reviewed papers: urban environment (physical + social), services, perceived safety, traffic/transport, cultural opportunities
Vuković, Koriugina, & Nekhorosheva (2022)	[23]	Comparative review of international city well-being rankings; indicator mapping across ranking systems	8 global rankings; indicators grouped into six well-being spheres; most frequent: environment and work; housing and health moderately frequent; leisure and finance less frequent

(*continued*)

Table 2. (*continued*)

Authors (Year)	Ref	Methodological ground	Relevant metrics/dimensions
Dobrowolska & Kopczewska (2024)	[24]	GIS-based fine-scale index; Objective assessability / amenities approach aligned with "15-min city"; weighted scoring + normalization	QOLI based on 8 categories (shopping, dining, education, healthcare, sport, transport, nature, other)
Tiran (2016)	[25]	Survey-based subjective QOL; SEM (MIMIC) + hierarchical multiple regression; model fit indices	Residential satisfaction (home, neighbourhood, city) + overall QOL as latent variable; general life satisfaction/happiness; domains affecting satisfaction include economic well-being, family life, social relations
Ferentz et al. (2020)	[26]	Composite sustainability indicator integrating QOL, well-being and happiness; multi-instrument survey; arithmetic aggregation	SDI Curitiba = mean of three tools: WHOQOL-BREF (4 domains), UWI (45 urban variables), GNH (9 domains); Likert 5
Ghaffari, Pirttikangas, & Gilman. (2025)	[27]	Review paper; taxonomy of indicators, methods and data sources	Multidimensional determinants (health, environment, economy, social factors, services)

3.2 An Integrated Methodological Framework for Urban Well-Being Assessment

The comparative analysis of the literature highlights a convergence towards multidimensional approaches to urban well-being assessment. Together with it, the analysis reveals the opportunity to integrate data-based measures of physical quality of the built environment with subjective dimensions related to residents' perception [26]. Based on this evidence, the research proposes a methodological framework (see Fig. 1) to assess urban well-being by integrating the two emerging approaches: a "quantitative" and "data-based" approach and the "qualitative" and "perception-based" approach. Such a framework allows for overcoming a merely data-driven approach to urban well-being and is consistent with the underlying rationale of the urban capability approach, as it complements the assessment of service availability with residents' perception, which reflects their effective opportunities to access and benefit from existing services [28, 29].

Concerning the "quantitative" and "data-based" approach, the integrated methodological framework provides a spatialized Urban Well-Being (UWB) composite indicator by adapting the methodology proposed from the QOLI (Quality Of Life Index) assessment in the city of Warsaw [24]. The choice of this methodology lies in its structural

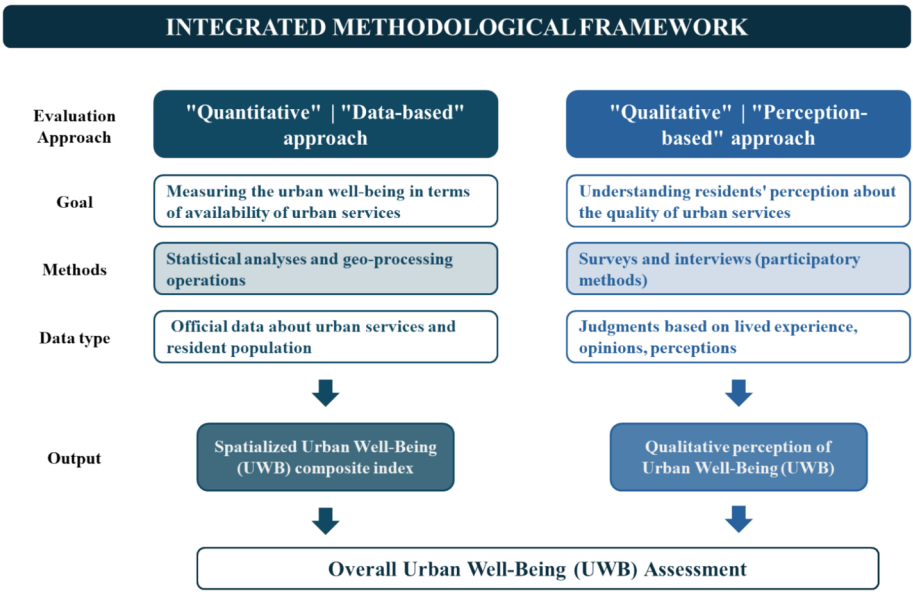

Fig. 1. Methodological framework for the assessment of urban well-being at the urban scale (Authors' elaboration)

clarity, replicability, and consistency with the logic of urban proximity. The "qualitative" and "perception-based" approach, instead, rests on a direct survey methodology [18, 26].

By integrating the two approaches, the proposed framework may provide a broader reading of the urban well-being phenomenon, which captures both the structural conditions of the urban environment and how they are experienced by inhabitants.

Turning to the implementation of the methodology for the "quantitative" assessment, the UWB indicator is assessed at a sub-municipal level, by considering, as an elementary spatial unit for the evaluation, a square cell of 1 km square, since it allows dividing the built environment into "spatial units" consistent with the logic of the 15-min city. The UWB assessment considers the urban services/amenities present in each cell, and those located in the 8 adjacent cells (first-order neighbourhood) by introducing a spatial weighting mechanism that attenuates the border effects [24].

More in detail, following Dobrowolska & Kopczewska (2024) [24], seven categories of urban services/amenities have been defined, as the most relevant for urban well-being: Restaurant, Transport, Health, Education, Sport, Shopping, and Nature. Within these categories, the different typologies of amenities are differently weighted based on their contribution to the quality of life of the resident population: greater weight is given to basic services, satisfying primary needs, while advanced or additional services are given a lower weight. To this aim, the amenities/urban services, within each category, are classified into a hierarchy of sub-levels of importance - primary, secondary, tertiary, and additional - reflecting the priority of the different types of services based on their relevance and frequency of use by the population. For each category, thus, the specific UWB sub-index is defined as the sum of the single contribution of the four levels of

services (Eq. 1):

$$icat = icat, \text{prim} + icat, \text{sec} + icat, \text{third} + icat, \text{add} \tag{1}$$

The index *icat*, prim captures the contribution of primary services to urban well-being for the specific spatial unit, and is defined as follows (Eq. 2):

$$icat, \text{prim} = \left[\frac{n(cell)cat, \text{prim} + Wnb \bullet n(nb)cat, \text{prim}}{Q3cat, \text{prim}} \bullet S_{\text{prim}} \right] \tag{2}$$

where:

- $n(cell)cat$, prim is the *per capita* number of primary services located within the cell;
- $n(nb)cat$, prim is the *per capita* number of primary services available in the 8 neighbouring cells;
- *Wnb* is the proximity weight of neighbouring services, accounting for their reduced accessibility compared to services located within the cell: it is placed equal to 0.5;
- $Q3cat$, prim is the third quartile of the distribution of per capita primary services across the urban area, used as a normalizing factor[1];
- $S_{\text{prim}} = 9$ is a scaling factor used to rescale the index to the desired range (0–9).

The index *icat*, sec captures the contribution of secondary services to urban well-being. It is computed using a binary approach with distance penalty: for each service category, only one amenity is considered. Based on this assumption, the index is defined as follows (Eq. 3):

$$icat, \text{sec} = \begin{cases} 0.3 if there is at least one secondary service within the cell \\ 0.15 if there is a secondary service in at least one neighbour.cell \\ 0 in the other cases (no secondary services) \end{cases} \tag{3}$$

The tertiary level index *icat*, third, considers the presence of two type of tertiary services for category and, like the second level index, is defined as (Eq. 4):

$$icat, \text{third} = \begin{cases} 0.4 if both services are represent within the cell \\ 0.3 if both services are in the neighbour.cells and one is in the cell \\ 0.2 if both services are represent within the neighbour.cells \\ 0.1 if only one service is in the nieghbour.cells \\ 0 in the other cases (no tertiary services) \end{cases} \tag{4}$$

Finally, the additional services index *icat*, add captures the variety of additional services, while imposing an upper bound (0.3) to prevent diversification from compensating for the absence of essential services. Its calculation is based on the following equation (Eq. 5):

$$icat, \text{add} = \min\{Wadd \bullet n(cell)cat, \text{add} + Wnb \bullet W\text{add} \bullet n(nb)cat, \text{add}; W\text{add}, max\} \tag{5}$$

[1] The third quartile was selected as the normalization factor to provide a robust and relevant benchamark. Unlike other standardization procedures (min-max standardization), which can be strongly influenced by extreme values or outliers, Q3 represents a high but representative level of service provision within the urban context.

where:

- $n(cell)cat$, add is the number of distinct types of additional services available within the cell;
- $n(nb)cat$, add is the number of distinct types of additional services available in neighboring cells;
- Wadd is the base weight assigned to each type of additional service within the cell (set to 0.1);
- Wadd is the proximity weight applied to additional services located in neighboring cells (set to 0.5);
- Wadd, max is the maximum cap imposed on the additive component (0.3).

The UWB sub-index, defined for each category and given by the sum of the four components (Eq. 1), thus, can range between 0 and 10. The Overall UWB index, defined at the cell spatial unit, can be derived as simple arithmetic mean of the 7 categorical sub-indices (Eq. 6):

$$UWBcell = \frac{iedu + ihealth + irest + ishop + isport + itrans + inat}{7} \tag{6}$$

This composite UWB index, also ranging between 0 and 10, provides a synthetic measure of the level of urban livability of each area. It should be noted that, as an average, the UWB index attenuates the extreme values of the individual categories: for example, a cell with higher service provision in some categories but deficiencies in others will obtain a balanced average score. The UWB index, therefore, must be read together with the categorical sub-indices: if the former offers a general and comparative overview across different urban areas, the latter allows identifying in which specific aspects an area excels or is deficient.

Given the proposed framework design, this "quantitative" assessment is integrated with a "perception-based" assessment component, defined through a questionnaire administered to residents. The questionnaire is structured in accordance with the 7 service categories of the UBW quantitative index and requires respondents to rate the quality of each service category on a 0–10 scale. This choice allows direct comparability between objective scores and individual perceptions.

By so doing, the proposed approach combines objective metrics of accessibility and availability of services with subjective assessments expressed by citizens. The comparison between the two levels makes it possible to identify any convergences or misalignments between "measured" and "perceived" well-being, strengthening the interpretative robustness of the analysis and providing operational support for planning decisions oriented towards the fair and sustainable improvement of urban livability.

4 Application Prospects: Insights from the Case Study of Siracusa (Italy)

4.1 Introduction to the Case Study

The desire to test the opportunities of the proposed methodological framework in assessing urban well-being and guiding planning choices calls for its application to a case study, identified in the city of Syracuse.

Syracuse is a city of about 120,000 inhabitants and extends over a municipal territory of over 200 km^2. It is in the south-east of Sicily, in Southern Italy, and it is a city with a rich historical heritage, from the Neapolis archaeological park to the historic center of the island of Ortigia, flanked by modern neighbourhoods and less dense peripheral areas. It belongs to the realm of medium-sized Italian cities, and its territorial variety offers a significant testing ground for the UWB methodology, allowing to assess urban well-being through indicators of accessibility to services both in consolidated central areas and in marginal areas. More in detail, the city of Siracusa is approached to test its distance from the theoretical models of the "15-min city", the "Just City", and the "City of Needs" [5, 10, 16]: based on the UWB index assessment, indeed, it is possible to understand the provision and distribution of urban well-being across different areas. Indeed, if an urban area perfectly adhered to the 15-min model, each cell would record high and similar UWB values. Applying the index to Syracuse, thus, allows for verifying the presence of imbalances in well-being distribution, while identifying "deficient areas" to orient planning actions.

4.2 The Proposed Methodological Framework Implementation

The implementation of the framework in the case of Syracuse first required the construction of a geo-database consistent with the spatial structure proposed for the UWB index assessment. The geo-referenced information about the different typologies of urban services included in the assessment was retrieved from Open Street Map (OMS), an open-source map service, which allows replicability of the model to other territories, up-scaling, and continuous updating.

Data were processed through the QGIS software. In an initial phase, urban services were filtered according to the 7 categories of the UWB (restaurants, transport, health, education, sport, shopping, nature), defining correspondence rules between OSM tags and the hierarchical structure of the index (primary, secondary, tertiary, and additional levels). At the same time, Istat demographic data were integrated to express the number of services in *per capita* terms.

The entire municipal territory was divided into a regular grid of 1 km by 1 km cells, generated in GIS and projected in the UTM WGS84 system (EPSG:32633). Through join and spatial intersection operations, each cell was associated with: the number of services per category and level; the resident population; and the services present in the 8 adjacent cells, to consider proximity and possibility to access services beyond the geometric boundary of the single unit [24].

Once the territorial database was structured, the category sub-indices were calculated by applying the formulas presented in Sect. 3.2, combining the *per capita* number of primary services, the presence of secondary and tertiary level services, and the additional contribution. The 7 sub-indices were finally aggregated using a simple arithmetic mean (Eq. 6) to obtain the overall value of the UWB index for each cell [24]. The process has made it possible to translate raw geospatial data into comparable synthetic indicators, making it possible to analyse the territorial patterns of urban quality of life in the case study.

4.3 Results

The analysis of the UWB Index for the municipality of Syracuse highlights a marked center-periphery gradient, with significantly higher values in the central urban areas and progressively lower values moving away from the urban core.

UWB per cell values vary from a maximum of about 9 (on a scale of 0–10), located in the heart of the urban area, such as Ortigia and Neapolis, to values close to zero in sparsely served low-density rural areas. The average UWB value is approximately 2.2, with a standard deviation of 2.4, reflecting a strong imbalance between a few very advantaged areas and a large part of the territory with deficient endowments. However, this average value is influenced by the inclusion of numerous marginal, agricultural or almost uninhabited cells, devoid of urban services, which lower the overall value without necessarily representing conditions of urban distress. However, the main emerging result is the already mentioned uneven distribution of urban well-being. Specifically, the north-eastern quadrant, coinciding with the compact coastal city, has better living conditions than the western inland hinterland, characterized by scattered settlements and predominantly agricultural functions. Peripheral localities, such as Cassibile (15 km south from the center) and Belvedere (8 km north-west), suffer from less accessibility to services, having to depend largely on the major center.

The "quantitative" results (see Fig. 2) can be explained by the heterogeneous urban morphology of Syracuse. Ortigia and the surrounding historical fabric play a leading role, concentrating cultural, commercial, and administrative functions, as well as consolidated public services. Semi-central neighbourhoods (Grotta Santa, Akradina, Santa Lucia, Neapolis) benefit from the proximity to the center, showing medium-high conditions. Conversely, peripheral districts developed through recent expansions or as detached villages display weaker urban well-being conditions. Epipoli represents an emblematic case: a predominantly residential area lacking structured local centralities and proximity services. Overall, this results in a polarized urban structure: a strong multifunctional center, a semi-central belt with a medium availability of services, and an outer ring characterized by low accessibility.

In addition to the "quantitative" evaluation, the "perception-based" assessment, based on a questionnaire to the residents, returned 54 responses. Consequently, as a first application, the analysis focused on the three neighbourhoods with the largest numbers of responses - Akradina (10), Neapolis (9), and Scala Greca (8) - thus ensuring a minimum, albeit limited, basis for comparison between the "quantitative" UWB index and its subjective counterpart (see Fig. 3) (Table 3).

The comparison between the two indices reveals a weak correlation between the "data-based" measure of urban well-being and the "perception-based" measure. In some cases, a certain level of coherence can be observed: for example, the lack of green spaces detected in Akradina and Scala Greca corresponds to moderately low levels of residents' satisfaction. In other cases, significant deviations emerge. The case of transport services is particularly evident: despite high "quantitative" scores, residents express lower satisfaction, suggesting that the mere presence of infrastructure does not automatically guarantee a positive perception, as factors such as frequency, reliability, and quality of experience have a decisive impact. Different is the case of local commercial

Table 3. Sample responses on subjective satisfaction by service category for the neighbourhood of Akradina (Authors' elaboration)

Respondent	Neighbourhood	Healthcare services	Education	Sport facilities	Shops and services	Nature	Public transport	Catering services
A	Akradina	2	6	6	8	5	4	6
B	Akradina	6	6	6	7	3	1	3
C	Akradina	4	4	4	6	2	1	1
D	Akradina	10	10	10	6	3	4	4
E	Akradina	6	6	7	7	5	2	6
F	Akradina	5	7	5	7	3	4	7
G	Akradina	5	7	5	7	3	4	7
H	Akradina	7	5	4	5	3	7	5
I	Akradina	7	5	6	7	5	5	5
L	Akradina	5	5	4	7	8	5	8

services: although these services' density is low in some areas, satisfaction remains on average sufficient, likely due to behavioural adaptations and reliance on nearby districts.

Overall, the comparison between the two dimensions confirms that urban well-being cannot be interpreted exclusively through quantitative indicators. Experiential aspects, individual expectations, and daily practices influence the perception of well-being. The integration between objective data and subjective evaluations is therefore fundamental for a more complete reading and for guiding planning interventions aimed at reducing territorial imbalances.

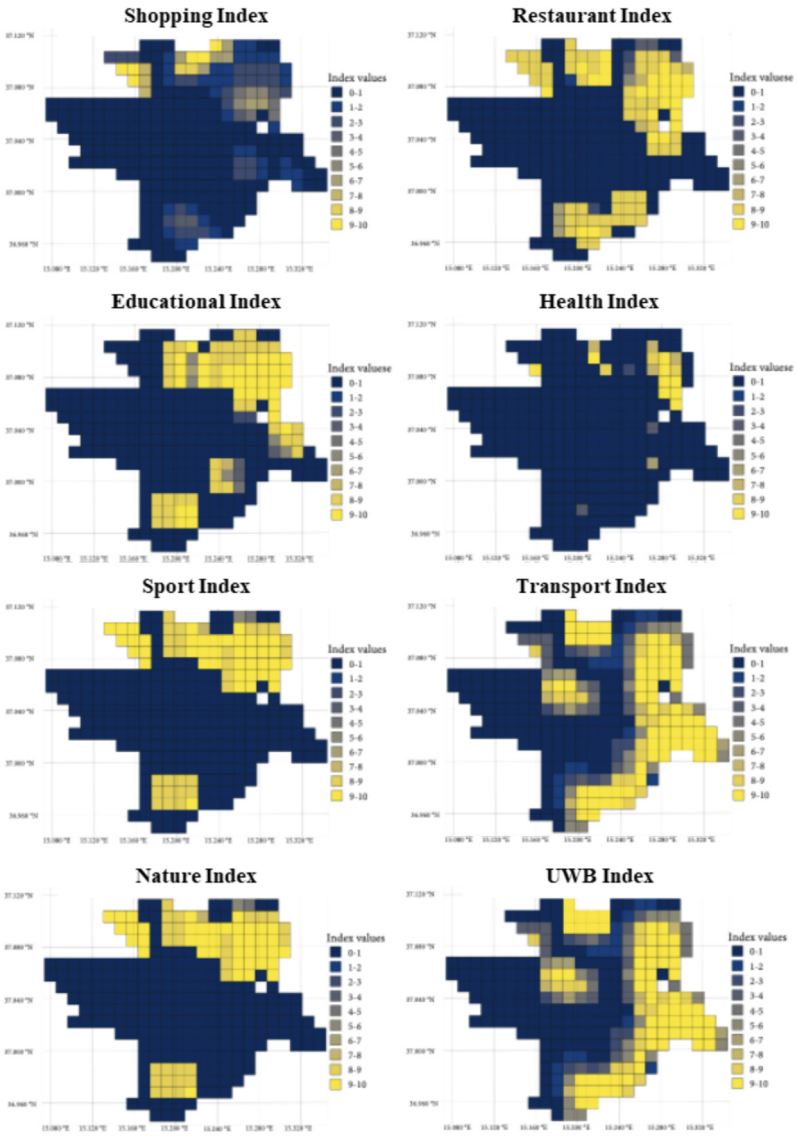

Fig. 2. Categorical sub-indices and UWB index for Siracusa municipality (Authors' elaboration on ISTAT and Open Street Map data)

5 Discussion and Conclusions

The paper addresses the issue of urban well-being through an integrated approach, with the aim of supporting planning decisions and orienting them toward spatial equity. The proposed methodological framework, based on integrating a "quantitative"/"data-based" assessment procedure and a "qualitative"/"perception-based" approach to the evaluation task, allows a complete and sensitive reading of urban dynamics and urban well-being

distribution mechanisms. The comparison between the results from the two assessment approaches, when applied to the Syracuse case study, reveals the opportunities of an integrated approach, highlighting that the quality of life does not always coincide with the mere availability of services. In some areas, there is consistency between the two assessment components' results; in others, significant deviations are recorded, confirming that qualitative factors, individual expectations, and practices significantly affect perceived well-being [22].

Furthermore, the application to Syracuse highlights the framework's potential in detecting intra-urban inequalities in well-being distribution. Historical areas and semi-central areas, with a higher density of services, show UWB higher values than those of peripheral areas, thus outlining an evident center-periphery gradient. The spatial support to the assessment allows for visualizing these imbalances and identifying fragile areas in terms of accessibility to services, thus providing a useful, albeit not exhaustive, tool for orienting urban policies at the municipal level from an equity and responsibility perspective.

However, it is necessary to recognize the intrinsic limits of the proposed framework and its output. The "quantitative" UWB index, by its nature, focuses on the proximity to services, neglecting complex subjective or social variables such as urban safety, social cohesion, air quality, or overall perception of quality of life [30]. Furthermore, the effectiveness of the model depends largely on the availability and quality of georeferenced data, which in medium-small urban contexts may be incomplete or inhomogeneous.

These limitations suggest research development prospects. First, the index can be enriched with new indicators that fill the current gaps (for example, indicators capturing further "dimensions", such as urban safety, air quality, noise, etc.) [31]. Secondly, the "qualitative" assessment component, currently proposed at its early stage and based on a participatory process, can be strengthened by involving citizens not only in the evaluation phase, but also in defining and weighting the dimensions considered. Another future development of the framework may investigate the adoption of alternative tessellation methods, such as hexagonal grids, which offer advantages in terms of isotropy and uniform neighbour relationships, thus assessing the sensitivity of results to the choice of spatial units.

Finally, applying the proposed methodological framework to other urban areas would provide additional evidence about its knowledge contribution from a comparative perspective, while testing its opportunities for scalability. These future research prospects, indeed, could strengthen the knowledge-generation potential of the framework, thus deploying its potential as a decision support tool to orient urban policies towards greater equity, awareness, and quality of life.

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