Environ Res Tec, Vol. 9, Issue 3, pp. 566-580, June 2026

Environmental Research & Technology
https://ertjournal.org/index.php
DOI: https://doi.org/10.35208/ert.1615227

REVIEW ARTICLE

Measuring livability in peri-urban areas using machine learning: A systematic review of key indicators and measurement frameworks

Kaushik G. PORIYA [1], Krupesh A. CHAUHAN [1], Kamal UPRETI [2 *], Rituraj JAIN [3], Puja KUMARI [4]

[1] *Sardar Vallabhbhai National Institute of Technology (SVNIT), Department of Civil Engineering, Urban Planning Section, Surat Gujarat, India*
[2] *CHRIST University, Delhi NCR Campus, School of Sciences, Department of Computer Science, Ghaziabad, India*
[3] *Marwadi University, Department of Information Technology, Rajkot, Gujarat, India*
[4] *Gautam Buddha University, Greater Noida, Department of Psychology and Mental Health, Gautam Buddha Nagar, Uttar Pradesh, India*

ARTICLE INFO

Article history
Received: 07 January 2025
Revised: 12 May 2025
Accepted: 05 June 2025

Key words:
Peri-urban, sustainable development, human development clustering, environmental sustainability index

ABSTRACT

Peri-urban areas are regions that exist between rural and urban centers and are rapidly growing urban centres that experience haphazard growth. Evaluating the livability of these areas is useful in enhancing the well-being of inhabitants as well as extending constructive development. Today, there is no universal agreement as to which indicators or frameworks should be used when assessing livability on the international level. This systematic review, therefore, aims to identify and compare essential critical livability indicators and measurement frameworks concerning rapidly growing peri-urban areas. Selected studies based on the PRISMA framework and machine learning analysis; 58 related studies were analyzed. This premise is evident based on the findings by the review, with major livability domains such as privileged access to basic services (89.66%), infrastructure resources (81.03%), housings (77.59%), and transport (74.14%). Environmental quality 68.97% as well as economic opportunities, 60.34% and social cohesiveness, 51.72% were also considered. The assessment methods ranged across surveys, reviews, ranking systems, and the construction of indexes, and always called for a combined as well as adaptable methodological framework. This study investigates the challenges of assessing livability in peri-urban areas, where traditional urban indicators often fail to capture context-specific dimensions. A systematic framework is developed that extracts and clusters livability indicators from academic literature. The study claims to provide knowledge to the urban management and policies towards designing per i-urban regions with sustainable and inclusive demands, focusing on system essentials and permanent, demanding solutions.

Cite this article as: Poriya KG, Chauhan KA, Upreti K, Jain R, Kumari P. Measuring livability in peri-urban areas using machine learning: A systematic review of key indicators and measurement frameworks. Environmental Research and Technology, 2026, 9 (3), 566-580.

INTRODUCTION

Life quality, to which livability directly relates, does not possess a clear and widely accepted definition. It contains broader parameters and sub-parameters that differ according to the place, time, purpose of the assessment, and the values of the assessor [1]. As a result, the meaning of the term 'livability' varies from one culture to another and from one organization to another [1]. Fundamentally, livability seeks to include all neighbourhood communities, allow difference in values and improve standard living [2]. A livable urban environment laid down principles are aimed at meeting needs/basics needs/ key necessities such that human precondition for physical survival is achieved besides promoting quality living through sustainability of buildings/ built environment by integrating economic, social and ecological imperatives [1].

Despite the proliferation of literature on urban livability, peri-urban territories are currently undergoing little analysis despite being effectively situated between rural and urban settings. These regions therefore experience challenges like rapid urban growth, chaotic physical development, and poverty and inequality Fight, all of which affect the quality of life and therefore hinder the achievement of sustainable development. Quantifying and analyzing livability of peri-urban spaces is therefore essential in the detection of constraint an opportunity to promote equitable development. However, the lack of benchmark and robust measurement tools and research frameworks that embrace the livability

* Corresponding Author: kamalupreti1989@gmail.com (Kamal Upreti)

This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

assessment of peri-urban communities poses a major research challenge.

Livability is a complex concept widely employed to assess the quality of human settlement life. Though it has been widely researched in urban contexts, peri-urban areas as transitional spaces between urban and rural spaces are normally omitted from conventional livability appraisal. Peri-urban spaces possess distinctive attributes such as hybrid land use, uneven infrastructure, socio-spatial fragmentation, and rapid population transformation.

Comparative Framework: Urban vs Peri-Urban Livability.
In urban environments, livability is usually measured by standardized indices such as the Mercer Quality of Living Index or the Economist Intelligence Unit rankings, with considerations for factors such as healthcare, public transport, crime, and education. Peri-urban areas, however, require a differentiated approach because of their heterogeneity. For example, whereas mobility to and from cities is crucial, in peri-urban areas, mobility to clean water, land security, or farm resilience. This research aims to develop a more refined framework for assessing livability in such dynamic environments. A common set of livability indicators specific to peri-urban environments, despite increasing scholarly interest, remains elusive. This research bridges this essential gap by systematically extracting and clustering pertinent indicators through machine learning techniques applied to a large literature base.

Choosing the right indicators for livability checks is even more complex when identifying peri-urban areas since the notion of livability is complex and an indicator solely depends on the peculiarities of the environment [3, 4]. More concerning present and future research proposals are several types of livability indexes or sub-domains which have to do with social, economic, physical, and environmental performance [5]. For instance, livability of metropolitan studies in Australia stress on 11 sub-domains, while Chinese research includes social civilization, economic advancement, and lived comfort [6,7]. However, most frameworks are mainly developed based on urban settings and do not consider specific features of peri-urban contexts.

Companies like the Economist Intelligent Unit and Mercer have gone further and created measurement indices such as the Global Livability Rankings and the Quality of Living Index [8,9]. The criteria used in these rankings are such areas as infrastructure, healthcare, and even environmental sanity. To some extent these tools offer useful information although generalised for peri-urban areas because most have an urban bias. In the same vein, India's Ease of Living Index [10] and Smart Cities Mission [11] focus on the urban parameters in infrastructure, energy and transport sectors, which do not adequately address the transitional and dual characteristics of peri-urban areas [12].

The analysis of studies of existing approaches demonstrates the presence of similar yet, at the same time, incompatible indicators and, as a result, difficulties with cross-contextual comparisons [13]. Lack of standard and comprehensive framework specific for peri-urban landscapes thus pose a challenge to a standard evaluation of livability across different environments. This limits not only the current assessments' accuracy but also hinder policymakers' capacity to develop adequate interventions for the identified regions. In order to avoid these limitations, this research is aimed at constructing a standard, multiple-stage model of peri-urban liveability measurement. In this study, an attempt to combine the social, economic, and environmental and infrastructural dimensions through the use of machine learning and participatory approaches is made. The approach applied here is intended to improve the accuracy and regional context of the livability assessments in peri-urban regions of the world.

The principal objectives of this research are as follows:

1. Assess Livability in Peri-Urban Areas: It is necessary to assess the quality of life due to the indicators which include infrastructure, accommodation and transports and quality of environment.
2. Identify Challenges and Opportunities: Address issues of governance, resource, and socio-economic and politics factors that continue to determine the quality of life in peri-urban areas.
3. Compare Urban and Peri-Urban Livability: It's important to defining convergence and divergence in an effort to appreciate the needs of peri-urban people.
4. Promote Sustainable Development: Promote the principles and policy formulation of environmental urban sprawl that meet long term growth, sustainable environmental standards and improved quality of life.

In doing so, this study helps to fill the existing research gap and gains new insights into the concept of livability and offers practical recommendations for accomplishing sustainable development in peri-urban areas.

LITERATURE REVIEW

Literature on urban livability evidence has grown in the last few years resulting in inadequate data for earlier meta-analyses [3,6,14–17]. Therefore, a new scoping assessment needs to be done to identify the areas that have been explored and those that still remain a problem. It is most useful for emerging and difficult to search research questions. It helps identify area of research with minimal literature carry out a quick literature review, quantify the volume of information or evidence available on a given topic and highlight concepts, theories, and application and policy implications [18,19]. The idea of 'peri-urban livability' had attracted much interest in the last decade or so, and numerous studies as well as organizations have used various ways to assess it. Drawing from the literature, the following sections focus on aspects, measures, assessment methodologies, and organizations for measuring the livability of peri-urban areas.

Aspects of Livability

In the context of socio-physical determinants of population residing in the peri-urban areas, the concept of livability may of course, cover the social, economic, physical and environmental dimensions of the population. These aspects are certainly linked together and make a common input to the quality of life in these transition areas. Social factors consist of cohesion of people, knowledge facilities, and cultural infrastructure. Economic procedures contemplate employment chances and economic progress. Physical aspects are more inclined towards infrastructure, the conditions of accommodation and transport. Pollution has an impact on fresh and processed air, natural and designed landscapes, and sustainability.

Key Metrics

The literature shows a number of variables that can be employed to measure livability in the peri-urban areas. Healthcare, education and utilities as the main prerequisites are becoming significant as the measures reveal the availability of facilities to a population. Another important

indicator is infrastructure standards referring to traffic Ways as well as public utilities such as roads etc. Overall, accessibility and adequacy of housing, and transportation, and transportation freedom and effectiveness, are often measured. According to some specific measures related to environmental quality, the environmental quality index may include characteristics such as air quality indices, availability of green spaces, and biological diversity indices. The third and fourth indices are often considered in terms of yardsticks that can be rather vague; they include economic opportunities and social inclusion, respectively.

Methods of Evaluation

Many researchers have used different approaches in assessing the level of livability in and around the PUA's. They are also used widely in completing various indicators to comprise a score of livability index and the sub-domains. These indexes will sometimes include quantitative yardsticks ramming to do with infrastructure as well as qualitative measures including the perception of residents. Scholars in several other studies have employed geospatial modeling and multi-criteria decision analysis in order to evaluate spatial livability at different levels of jurisdiction. Recently machine learning techniques have come into use to predict the indicators of livability and examine relationships between multiple factors.

Organizations and Authorities

While evaluating the livability in urban and peri-urban areas, several international organizations have come up with indicators. Economist Intelligence Unit responsible for disseminating the Global Livability Index and it measures stability, health, culture and climate, education, and infrastructure. Another well-known assessment is Mercer's Quality of Living Index taking into accounts political and economic risks, and public services. The Organisation for Economic Co-operation and Development (OECD) has provided services that use the Better Life Index with which one can compare the well-being of different countries with reference to eleven facets; social, environmental and economical [20]. These organizations' methodologies, which are mainly to some extent, urban-based give some insights that could be scaled down to the peri-urban settings.

Comparative Analysis of Existing Studies

The major factors, measures, methods of assessment, limitations, and frameworks together with the identified challenges and gaps concerning peri-urban livability are summarized in Table 1 based on the overview of the existing studies and methodologies. Standard of living indicators, including social and various economical services such as access to housing, health care, employment and education are important in determining the livability indices [8,9]. On the other hand, objective dimensions such as the physical environment, housing, transport and environmental quality are important in such models as the Better Life Index and city livability indices [4,13]. While these metrics provide significant information, the methods, which are employed for their assessment, are quite dissimilar. Questionnaire methods [21, 22] are useful to collect individuals' attitudes as it does not contain much variability across different scenarios. On the other hand, international benchmarks including those of the Economist Intelligence Unit and Mercer while useful offer few localized frameworks applicable to peri-urban areas [8,9].

Critical Evaluation of Methodologies

The methodologies discussed above suggest an approach that uses static data which hardly fits the dynamic peri-urban environment characterized by relatively rapid urbanization and socio-economic transformation. Some limitations are explored below: There will always be focus on metros with many indices such as the Ease of Living Index[10] developed mainly for urban area s while the peri-urban areas face different challenges such as; uncontrolled expansion, inequality among others [7, 11]. Furthermore, there is low representation of community in the current methodologies; participatory approaches form the basis of developing the frameworks since they suit the local needs [6, 23]. For instance, research articles like [24] employ satellite data and machine learning for quantifying the changes in the land cover, but the results offered are mostly insightful at the operational level with very little guidance on what action needs to be taken by the policy makers. Likewise, although [25] discusses relationships between agriculture and urbanization, it does not advance such relationships to constructively model the degree of livability. The following is another key issue, the geographical area of interest in most of the conducted studies tends to focus on the developed part of the world, thus little is well understood regarding peri-urban zones in developing economies [3,14-17].

Most Cited Articles on Peri-Urban Issues

A gear motor includes a gearbox that helps increase torque and reduces RPM. This setup drives a conveyor that collects waste. The gearbox gears change the shaft's speed and torque at specific ratios, allowing the shredder to crush the garbage. The motors are connected to 11 outboard MD2 at pins 11, 12, 13, and 14 on the motor driver to control their movement.

Social Dimensions of Livability

Social indicators are essential to livability, particularly in transition areas. Research like [6, 23] shows that community togetherness, security, and availability of public services in cities matter. But informal settlements, migration, and land rights concerns in peri-urban areas make social analysis challenging. They are usually left out of standard urban indices, which results in an inaccurate representation of livability in peri-urban areas.

Economic Indicators and Livelihood

Urban-led indices favor employment, earnings, and business networks. In peri-urban contexts, though, dual economies tend to exist alongside formal jobs on the urban periphery and casual agricultural or services-based livelihoods. Several studies [8, 9] indicate that income indicators fail to effectively register economic precarity in these areas.

Environmental and Ecological Metrics

Environmental quality continues to be an essential livability dimension. Where air quality and parks dominate the urban indicators, peri-urban indicators must include land-use conversion, distance from waste dumping grounds, and flood risk. Researchers such as [24, 25] advocate for adaptive environmental systems responsive to ecological disarticulation due to unguided growth.

Table 1. Comparative analysis of existing studies

Aspect	Key Metrics	Evaluation Methods	Limitations	Organizations/ Frameworks	Citations
Social	Community cohesion, access to education, cultural amenities	Survey-based approaches, participatory frameworks	Subjective metrics may lack consistency across contexts; limited community engagement	OECD Better Life Index	[6, 23]
Economic	Employment opportunities, economic growth	Multi-criteria decision-making, economic opportunity indexes	Focus on urban areas, neglecting peri-urban socio-economic disparities	Mercer's Quality of Living Index	[8, 9]
Physical	Infrastructure quality, housing quality, transportation systems	Standardized frameworks (e.g., Mercer, Economist Intelligence Unit); satellite and geospatial data analysis	Overemphasis on urban cores; frameworks like the Ease of Living Index are urban-centric	Economist Intelligence Unit (Global Livability Index)	[4, 7, 11, 13]
Environmental	Air and water quality, green spaces, sustainability practices	Environmental monitoring (satellite data, machine learning), biodiversity metrics	Descriptive findings offer limited actionable insights for policymakers; lack of dynamic adaptation for rapid changes in peri-urban areas	Frameworks emphasizing sustainability (e.g., Global Livability Index)	[24, 25]
Composite Livability Index	Aggregation of multiple indicators (e.g., stability, healthcare, culture, environment, education, infrastructure)	Static data reliance, limited geospatial integration	Fails to capture localized nuances in peri-urban contexts	Economist Intelligence Unit, OECD Better Life Index, Mercer	[5,6,8,9]
Emerging Techniques	Machine learning applied to large datasets, geospatial modeling	Advanced data integration, uncovering patterns in livability	Findings are primarily descriptive; integration into actionable frameworks remains a challenge	Research organizations adopting modern technologies	[14-17, 24]
Participatory Methods	Localized surveys, stakeholder engagement	Tailored frameworks for local contexts	Underrepresentation in existing methodologies	Potential in developing new frameworks	[6, 23]
Contextual Gaps	Focus on developed regions, neglecting developing economies	Limited contextual understanding of peri-urban issues (e.g., unplanned growth, agriculture-urban interactions)	Fragmented geographical focus	Adaptations of existing global frameworks	[3, 10, 14–17]

Infrastructure and Service Accessibility

A vast majority of city-level indices calculate public transport, utility, health care, and educational infrastructure. Peri-urban areas suffer from these presumptions, since fundamental infrastructure becomes intermittent or zero in such cases. The peri-urban zones tend to lack infrastructural lag, fragmentation, and confused governance [11, 13].

Limitations of Existing Livability Indices

Most used livability indices, including the Mercer Index, EIU Livability Index, and OECD Better Life Index, have a strong urban bias. They tend to use formal datasets that are not available for peri-urban areas, presume centralized infrastructure and planning, and overlook informal settlements and transitional land use. Several high-profile livability indices are commonly utilized to assess urban quality of life, though each has strengths and weaknesses when it comes to application in peri-urban settings. The Mercer Quality of Living Index, which is based mainly on global cities, is characterized by rigorous and standardized methodology. Yet its extreme urban bias and relative neglect of informal settlements and transition areas make it very limited in its relevance for application in peri-urban regions. Likewise, the Economist Intelligence Unit (EIU) Livability Index is intended for large metropolitan areas and is best at cross-national comparability. However, it overlooks the intricacies of the rural–urban continuum, which makes it less applicable to peri-urban settings that reflect both aspects.
The OECD Better Life Index, which aims chiefly at developed countries, is noteworthy for covering a wide array of social indicators, such as education, health, and environmental quality. However, it is reliant mostly on national-level data, which tends to be inadequate in terms of the spatial sophistication necessary to portray the localized dynamics of peri-urban areas. Consequently, although the OECD index can provide middling relevance for peri-urban environments, it must nonetheless undergo major transformation to appreciate localized detail.

Figure 1 presents citation rankings by the authors and highlights the differences in the authors' contribution and citation scores of the peri-urban research papers. The second graph in Figure 2 also shows how the research perspectives are distributed where the thematic areas of focus include the peri-urban agriculture, land use change, social aspects, and environmental issues in the related studies. Figure 3 depicts total citations of the journals that has involved in publishing peri-urban researches and their impact on the academic and policy discourses in the specified period.

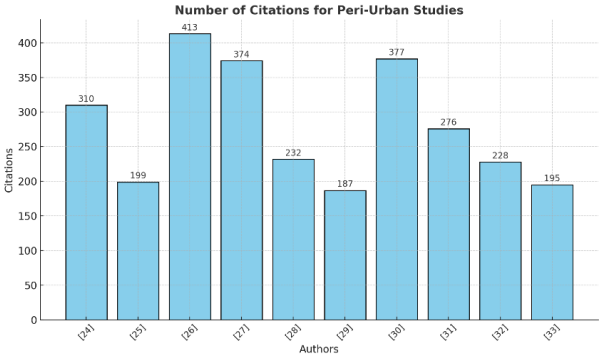

Figure 1. Visualization of the number of citations each author received

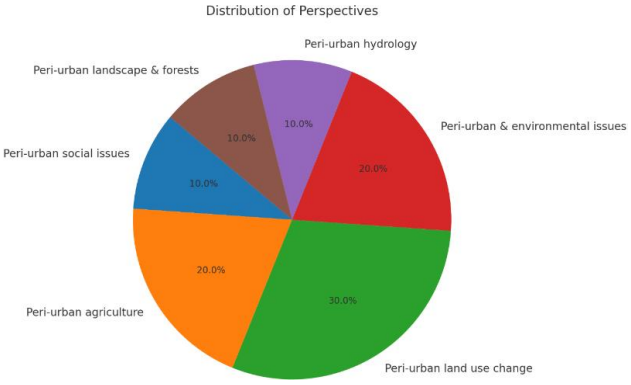

Figure 2. Illustrates the distribution of different perspectives addressed in the studies

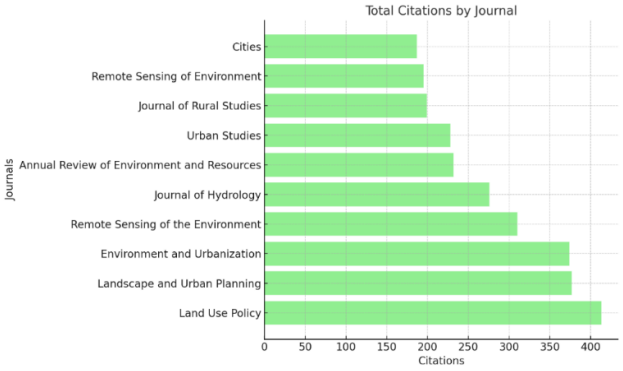

Figure 3. Highlights the total citations attributed to each journal areas

Table 2. Most cited articles on peri-urban issues

Authors	Perspectives	Journals Areas	Cited By
[24]	Peri-urban land use change	Remote Sensing of the Environment	310
[25]	Peri-urban agriculture	Journal of Rural Studies	199
[26]	Peri-urban agriculture	Land Use Policy	413
[27]	Peri-urban & environmental issues	Environment and Urbanization	374
[28]	Peri-urban & environmental issues	Annual Review of Environment and Resources	232
[29]	Peri-urban land use change	Cities	187
[30]	Peri-urban landscape & forests	Landscape and Urban Planning	377
[31]	Peri-urban hydrology	Journal of Hydrology	276
[32]	Peri-urban social issues	Urban Studies	228
[33]	Peri-urban land use change	Remote Sensing of Environment	195

Limitations of Existing Frameworks

A common feature which emerged from the reviewed literature is the lack of a comprehensive and integrative model for evaluating a community's resilience in the peri-urban settings. To some extent, these assumptions are true, yet several important limitations account for this gap. Another possible problem is related with data availability and quality, as most of the researches rely on the limited, even outdated and spatially inhomogeneous data, which do not take into consideration temporal and spatial changes typical for the peri-urban zones [6]. A further important limitation type can be attributed to contextual blind spots; the metrics conceived in relation to UCs fail to consider the socio-economic and infrastructure in PUs [13, 15]. Further, it becomes problematical regarding scale since frameworks point-designed may not be easily adapted for cross-jurisdictional analyses [4, 9]. These challenges illustrate that there is a pressing opportunity to engage dynamic, participative methods and utilize capacities of the machine learning and geographic information analysis to advance the sustainability of the livability tools.

Connection to Proposed Frameworks

Therefore, this review will create the needed understanding in outlining a framework for evaluating peri-urban livability. Some of the insights that arose from the literature include the need to use participative method that enhances the inclusion of the views of the community in the evaluation process [6, 23]. Furthermore, the use of machine learning and satellite data for real-time monitoring of peri-urban conditions is considered as the benefits for improving the livability indicators [13, 24]. However, global comparability and allowable local adaptation remain an essential component of the proposed multifaceted framework that needs adequate coverage [4,8]. This paper aims to fill these gaps, by demonstrating how the proposed framework will offer a comprehensive approach to evaluating and enhancing the livability of peri-urban spaces.

METHODOLOGY

To conduct the systematic review for the study, the PRISMA recommendations detailed in [34] informed the method used. The mentioned approach enabled a comprehensive review of related scientific sources; at the same time, it defined clear study aims and purposes, as well as provided for the comprehensive evaluation of existing knowledge in the field [35, 36]. The inclusion criteria were applied at the time of document search and selection to identify the research that must be further considered.

We employed a mixed-method NLP + ML methodology to identify livability markers from a collection of 58 peer-reviewed articles. The process consisted of a systematic literature review, data preprocessing, feature extraction, unsupervised clustering, and validation.

The combination with machine learning increases the efficiency and effectiveness of the review process in line with the presented methodology. Thus, high-frequency words present in the metadata of reported studies were reviewed through the help of the algorithms to reveal trends in the literature. Software such as VOSviewer was used in the bibliometric analysis through which activity matrices were generated, and important keyword connections were emphasized.

Due to the incorporation of NLP tools, the review process had cordial customer flows for text analysis and made it significantly easier to identify relevant information. Moreover, through machine learning, the dependency between multiple livability factors was also recognized. The above approach made it possible to undertake a complex dissection of the relations that exists between various qualitative aspects such as basic services, infrastructure, housing, transportation and environment with a view to determine the quality and overall livability of peri-urban areas. Therefore, this approach not only enhanced the effectiveness and coverage of the literature search; this also led to the formulation of a better-defined and more objectively quantifiable definition of the factors impacting on livability in peri-urban territories.

Literature Search and Selection Strategy

The content of this effort was derived from PRIMO which was accessed on September 8th, 2024. An analytical search provides the opportunity to explore in turn several knowledge sources – databases, journals, books, collections and digital sources. Currently, the authors have the social scientific databases through PRIMO such as ScienceDirect, Elsevier, Springer, and JSTOR for their research. Since there is a single search box and the results are organized in a condensed list in a single interface, PRIMO is an easy-to-use search framework that encompasses speedy and basic search over multiple electronic sources of information. During the whole process of search, the authors applied the possibility of filtering and limiting offered by PRIMO. The initial search used the term "peri-urban livability indicators", which generated a broad set of results. Further refined searches included combinations of keywords such as "measurement frameworks," "human development index," "peri-urban land use," and "urban sprawl." To maintain consistency with the research focus, only material published between 2000 and 2024 and written in English was considered. Through filtering by relevance and content type (peer-reviewed articles, book chapters, and open-access scholarly content), the initial results were narrowed significantly. The use of PRIMO allowed integrated access to multiple databases, simplifying the application of filters and keywords. Last, the search was limited to English language articles to ensure that the finding was easier to read and understand.

When the researchers excluded the articles that did not meet three criteria, the articles were filtered by the title using the four keywords "peri-urban", "livability", "indicators", and "measurement frameworks". These standards based on conceptual definitions of the most significant meso components of the research field were established by two subject-matter experts. Out of 210,743 records, 112,317 records were excluded from the search as authors screened and scanned the titles of the identified entries. Published research only for the purpose was selected because published articles, books or book chapters are likely to cover more topics and are less likely to be incomplete. Another criterion selected was to search the major open-access web databases recognizable all over the worldwide, such as Springer, Taylor & Francis, ScienceDirect, and JSTOR. The number of papers was thus cut down to 405 through these criteria and 15 were deleted on grounds of being duplicates, and therefore 390 articles' relevance was assessed after proper analysis had been conducted. The main terms that were employed to find and select the required publications are reflected in Table 3.

The documents evaluated were analyzed for its metadata, which generated keywords amounting to 12, 683 through the

tool VOSviewer. To cut down the number of keywords, the ones that were used five and more times were selected, which in total made 1802, according to Figure 4. Other peri-urban research-related topics or search terms identified include urban development, water supply, determination of peri-urban boundary, governance approach, peri-urban expansion and ecosystem surveillance, and vulnerability analysis. They can be used as future study directions. citation analysis procedures were employed to develop a network map showing the relationship between the keywords that were used in 405 articles on peri-urban studies. This way, the size of the circle represents the frequency with which the specific keyword appears and the larger the circle the higher the frequency.

The documents identified have been critically reviewed, looking into their appropriateness and relevance to quality and quantity-based studies to be conducted further. The articles were evaluated at this stage of the process for their ability to contribute towards future studies. Table 4 provides an outline of criteria for inclusion and exclusion in the evaluation process.

Literature Review Workflow

A total of 210,743 records were initially identified through database searches. After removing duplicates (n = 98,426), 112,317 records remained. Screening by title and keyword reduced the pool to 405 relevant records, which were further assessed for full-text eligibility (n = 390). After excluding 322 articles that did not meet the inclusion criteria, 68 studies were included in the final systematic review. Of these, 58 studies were deemed suitable for NLP and machine learning-based clustering analysis. The strategy of identifying research based on the PRISMA statement is illustrated in the Figure 5.

Table 3. Search strategy keywords

Sr. No.	Keywords
1	Peri-urban
2	Livability
3	Indicators
4	Measurement frameworks
5	Human development index
6	Peri-urban land use
7	Urban sprawl
8	Safety management
9	Peri-urban agriculture
10	Human Expansion Index
11	Conservational Sustainability Index
12	Quality of Life Index

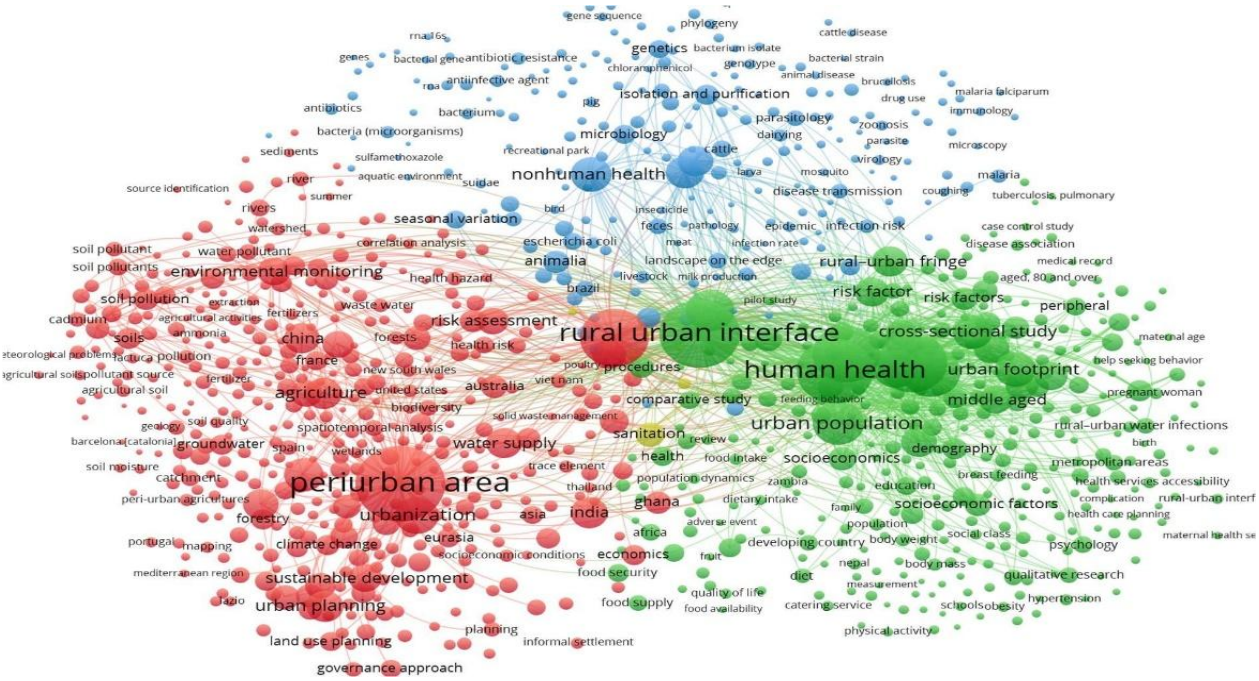

Figure 4. Keyword analysis map

Table 4. Inclusion and exclusion principles for systematic review

Inclusion Criteria	Exclusion Criteria
I1: The paper must have undergone peer-review.	E1: Articles not discussing urban or peri-urban livability
I2: The paper must be written in the English language.	E2: Articles not providing measurable or conceptual indicators
I3: Studies published between January 2000 and March 2024.	E3: Duplicate or inaccessible full texts
I4: Papers must be published research or full-article publications.	E4: Ph.D. theses, working papers, and project deliverables.
I5: The standard of the paper should be blind to impact factor.	E5: Review papers or editorials without an empirical basis

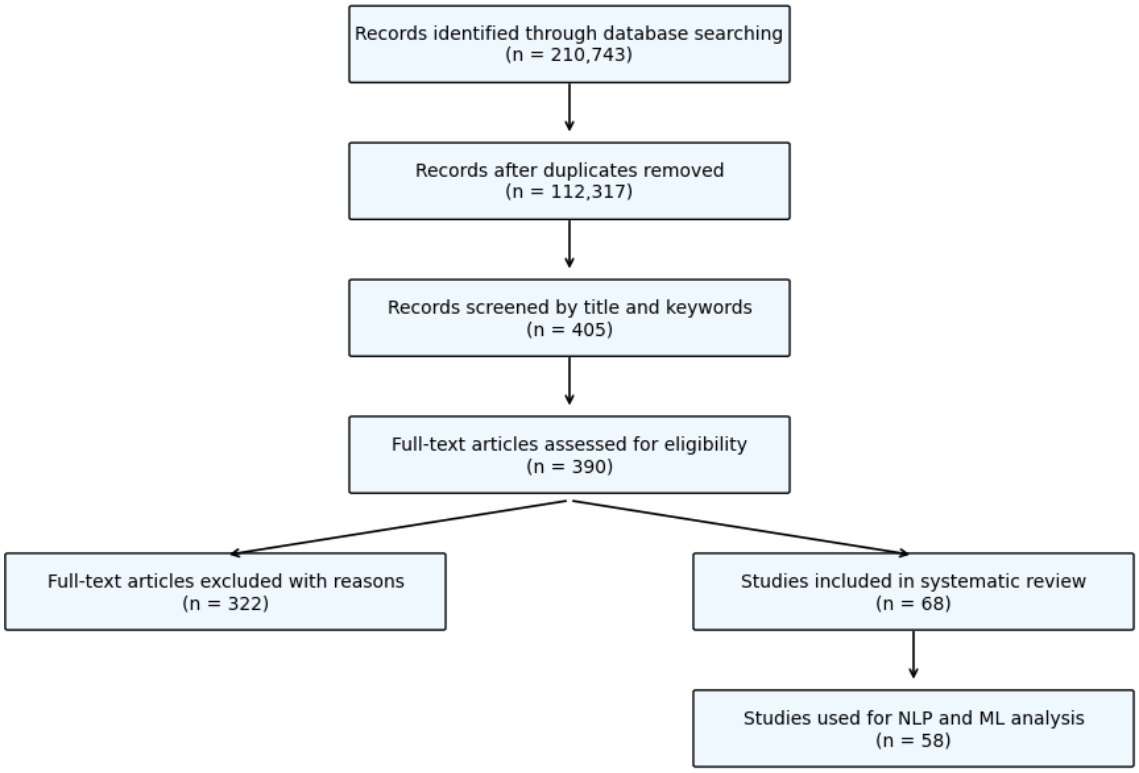

Figure 5. PRISMA flowchart of the review study

NLP and Clustering Pipeline

To prepare the corpus of 58 peer-reviewed studies for machine learning analysis, a systematic text preprocessing pipeline was employed. The raw text was first converted to lowercase to ensure uniformity across tokens. Subsequently, stopwords were removed using the NLTK library to eliminate commonly used words (e.g., "and," "the," "of") that do not contribute meaningful semantic value. Tokenization was subsequently used to split the text into words or tokens and then lemmatized, which brought words back to their base or root word (e.g., "communities" to "community"). Phrase chunking was also done to get significant n-grams (e.g., "urban infrastructure", "public service access") to get more context-rich representations of important livability terms. For the feature extraction, the Term Frequency–Inverse Document Frequency (TF-IDF) method was adopted to convert the preprocessed text into a numeric matrix. The approach gives more weight to words that occur more in a particular document but less in the whole corpus, and hence is specially chosen for the recognition of domain-specific livability indicators. Although TF-IDF was the main method used in this research, future work could consider employing more sophisticated methods like word embeddings (Word2Vec or BERT) to capture higher-level semantic meanings between words.

The optimal number of clusters was determined via the Elbow Method and Silhouette Score Analysis as shown in Figure 6.

The feature vectors after transformation were then fed into unsupervised clustering for discovering thematic clusters of livability indicators. K-means clustering was used because of its speed and interpretability. Both the Elbow Method and Silhouette Score Analysis were applied to find out the optimal cluster number (K). The Elbow Method is used to identify when further increases in the number of clusters provided declining returns in the form of variance within clusters. The Silhouette Score measured cohesion within clusters, together with separation of clusters. Based on these assessments, a best K value of five was chosen, which well captured the most prominent themes in the literature concerning social cohesion, economic livelihoods, environmental health, infrastructure access, and governance.

```
from sklearn.cluster import KMeans
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import silhouette_score

vectorizer = TfidfVectorizer()
X = vectorizer.fit_transform(text_corpus)

sil_scores = []
for k in range(2, 10):
    km = KMeans(n_clusters=k, random_state=42)
    km.fit(X)
    sil_scores.append(silhouette_score(X, km.labels_))
```

Figure 6. Silhouette coefficient analysis for peri-urban indicator clustering

RESULTS AND DISCUSSION

According to the 49 researches reviewed in this paper, livability in areas(peri-urban) can be measured using a variety of variables, including infrastructure, housing, transportation, and environmental quality. The assessment stressed the significance of using a multifaceted, participatory method to measure livability that takes into consideration social, economic, and environmental aspects as well as the opinions and demands of the local community. The review's conclusions can be applied to measuring frameworks and policies that aim to increase livability in peri-urban areas and support sustainable urban growth.

Approaches for Evaluating Livability in Urban

The study identifies significant differences between East and West in the methods currently used to assess livability in

urban research [21,37-39]. While livability research was first studied by academics with [40-44], this trend later spread to Asian nations in the early 2000s. The politics of livability in Asian nations like China, India, Malaysia, Taiwan, and Korea have been extensively studied [45-47]. Other authors [48-51] initially focused their research on evaluating physically accessible amenities and facilities, but as globalization and liberalization progressed, the emphasis shifted to analyzing the 'socio-economic' effects of growing suburbanization inside conurbations.

Urban administration policies have made use of the livability idea [52]. The concept of livability pertains to human growth and the well-being of communities, with a focus on the physical, environmental, and cultural elements of cities and the surrounding areas [53-55]. The ability to live in certain physical locations with the required preparation in terms of cultural and environmental factors is known as livability [13,23,56]. Organizations and scholars have defined livability methods according to their perspectives and research settings. For instance, the Clinton Livability Agenda [57] defined it as a best practice that encourages communities to maintain green space, choose eco-friendly transport options, and pursue regional intelligent growth policies for a sustainable future [58]. The Australian Bureau of Statistics [59] linked it to well-being and how well a society meets its people's needs.

According to [60], livability techniques have a variety of intricate traits, urban patterns, and shapes. It is seen as a orientation to urban residing benchmarks or general welfare by many scholars and politicians. To evaluate residing conditions in cities, many international organizations have developed livability methodologies [13,22,61-63]. The Economist Intelligence Unit (EIU) publishes an annual Global Livability Index to evaluate the standard of living in different regions [63]. Cities are ranked in the index based on five weighted factors: infrastructure, healthcare, culture and environment, education, and stability. In a similar vein, Mercer's Quality of Life (QoL) evaluation evaluates living standards around the globe and recommends 450 destinations based on 10 socioeconomic parameters [64]. The top three cities on the list in 2018 were Auckland, New Zealand, Zurich, Switzerland, and Vienna, Austria. The Organisation for Economic Co-operation and Development (OECD) uses the Better Life Index (BLI) survey to rate livability according to eleven social, environmental, and economic factors [20]. Another tool developed by the American Association of Retired Persons (AARP) is the Livability Index for American cities that targets livable places with respect to housing quality, community aspirations, transit, environmental quality, health and economic participation [65-73]. This measure was conceived due to the rapid growth of the development and link it with the residents' change, especially in the elderly population.

In concluding the studies mentioned above, the concern is raised on the centrality of the concept of livability and the aspects under which it comes with; it is seen that apart from objective assessment, livability incorporates objective concerns such as the feelings of residents, their level of satisfaction, among others. They also indicate that data collection and inclusion of the community in livability assessments are crucial. The role of technology in enhancing the livability is also evident from a number of the studies. Finally, the research suggest that the concept of livability is culturally sensitive and varies from city to city and even from region to region. Explanation of comparative analysis for the following studies is done in Tables 5 and 6.

Comparing different definitions of and assessment approaches to livability is provided in Table 5. It divides approaches into five major ideas. The first idea concerns the evaluation of the livability and associated approaches in urban studies – ref. The second idea looks at the temporal and politics part of livability literatures. The third concept deals with the definitions and outlooks on livability, and uses sources such as Australian Bureau of Statistics and the Clinton Livability Agenda. The fourth concept deals with the nature and level of challenges towards transforming the communities into livable forms. The last idea teaches about international organizations and their approaches to measure liabilities. Figure 7 elucidates the bibliometric network of Comparative Analysis of Livability Definitions and Assessment Methodologies.

Table 6 and Figure 8 presents a Comparative Analysis of Methodologies and Key Findings in Measuring Urban Livability. Studies like [22,64,65] address Residents' perception of livability in India linked to socio-economic factors and access to services, ranking of cities based on socio-economic factors, and the livability index for American cities focuses on housing quality, transportation options, and economic engagement. Works of literature like [13, 23, 47-50, 57, 62] address Residents' perception of livability in China's provincial capital cities linked to economic development, transportation, and environmental quality, Two-dimensional approach to measuring urban livability that considers social and economic factors, Livability involves multiple dimensions, including physical, social, and environmental factors, Livability can be measured but is a complex concept with subjective elements, Importance of considering sustainability in measuring urban livability, Definition and components of urban livability are complex and vary across contexts, Importance of considering social, economic, and environmental factors in evaluating livability, Residents' satisfaction is an important component of livability.

Table 5. Comparative analysis of livability definitions and assessment methodologies

Concept/Approach	Authors/Journals	Citation Number
Livability assessment methods in urban research	Andereck and Nyaupane, Sofeska, Chen and Fazilov, Mouratidis	[21, 37-39]
Historical trend and political aspects of livability research	Barry, Rusk, Kashef, Chang, Vela et al., Ellis and Roberts, Randhawa and Kumar, Li and Yao, Wyatt, Tilaki et al., Gough, Xu and Guo	[40-51]
Definition and perspectives on livability	Australian Bureau of Statistics, Clinton Livability Agenda	[13,23,52-56, 58]
Characteristics and complexity of livability	Farber et al.	[60]
International organizations and their livability methodologies	Economist Intelligence Unit, Mercer, Organization for Economic Co-operation and Development, American Association of Retired Persons	[20, 63-65]

Table 6. Comparative analysis of methodologies and key findings in measuring urban livability

Reference	Methodology	Key Findings
[13]	Review	Residents' satisfaction is an important component of livability
[21]	Survey	Residents' quality of life perceptions positively affected by tourism
[22]	Survey	Residents' perception of livability in India linked to socio-economic factors and access to services
[23]	Review	Importance of considering sustainability in measuring urban livability
[38]	Review	Challenges in evaluating urban livability in China due to lack of standardization and data
[40]	Review	Urbanization has potential to promote sustainability and livability
[42]	Review	Importance of considering multiple dimensions of livability in evaluation
[43]	Review	Smart technology can enhance urban livability
[44]	Survey	Residents' perception of livability in Sofia linked to social and environmental factors
[45]	Index construction	Livability index can capture differences in urban dynamics within a city
[46]	Survey	Residents' perception of livability in China's provincial capital cities linked to economic development, transportation, and environmental quality
[47]	Index construction	Two-dimensional approach to measuring urban livability that considers social and economic factors
[48]	Review	Livability involves multiple dimensions, including physical, social, and environmental factors
[49]	Review	Livability can be measured but is a complex concept with subjective elements
[58]	Review	Definition and components of urban livability are complex and vary across contexts
[62]	Review	Importance of considering social, economic, and environmental factors in evaluating livability
[64]	Ranking	Ranking of cities based on socio-economic factors
[65]	Index construction	Livability index for American cities focuses on housing quality, transportation options, and economic engagement

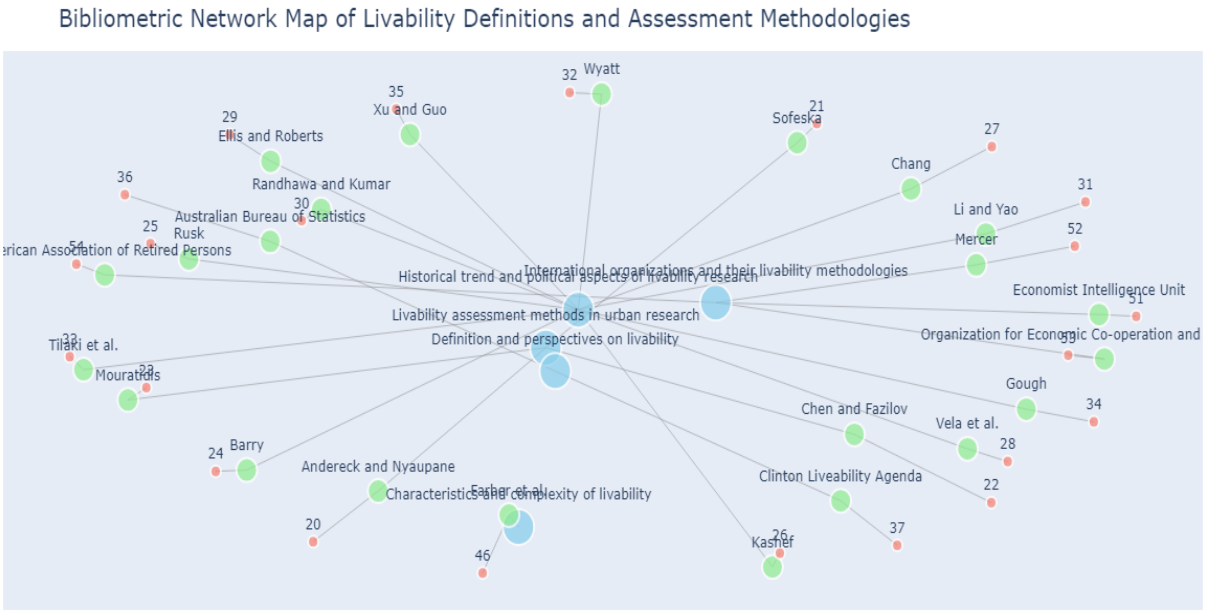

Figure 7. Comparative analysis of livability definitions and assessment methodologies

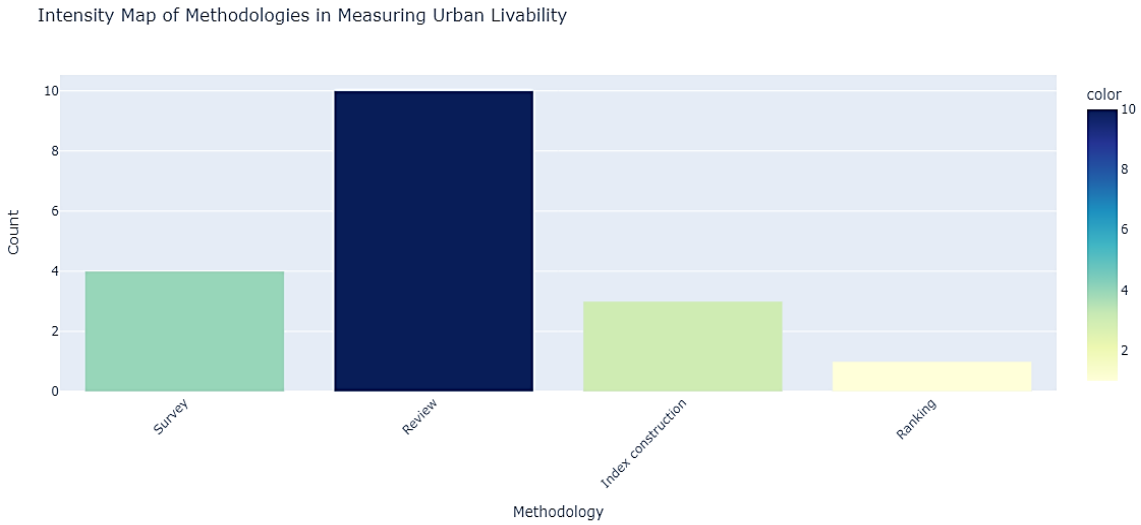

Figure 8. Comparison of metrics by dataset and method

The objective of this systematic review research was to identify the most important livability indicators and measuring techniques. The following keywords were utilized in the search strategy: "peri-urban," "livability," "indicators," and "measurement frameworks." 58 relevant studies were found via the search, and these were evaluated and examined in accordance with the given inclusion criteria. For this review, the studies identified peri-urban settings where livability was measured and contained definitive livability indicators or a definable measurement framework. Any research that failed to focus on peri-urban livability or that failed to employ any of the livability markers or assessment techniques were eliminated from analysis. From the results of the above research, conclusions were made on the identification of leading livability indicators and assessment approaches. In another data collection process, the study discovered the elements often employed to quantify the livability factor including infrastructures, housing, transport system and the state of the surrounding environment. The analysis also paved way to the enhancement of a complex approach to measure livability that includes social, economic, and environmental factors. The evaluation proposed the use of methods that include the voices and needs of the neighbourhood when determining the livability. Machine learning algorithms particularly, NLP and clustering techniques, analyzed the metadata from 58 relevant studies. The Key indicators and their frequencies of occurrence were mapped, revealing the following results as shown in table 7. The frequency of Livability Indicators in Peri-Urban Areas is shown in Figure 9.

Table 7. Frequency of livability indicators in peri-urban areas

Indicator	Frequency of Occurrence	Percentage (%)
Access to Basic Services	52	89.66
Infrastructure	47	81.03
Housing	45	77.59
Transportation	43	74.14
Environmental Quality	40	68.97
Economic Opportunities	35	60.34
Social Cohesion	30	51.72
Health Services	28	48.28

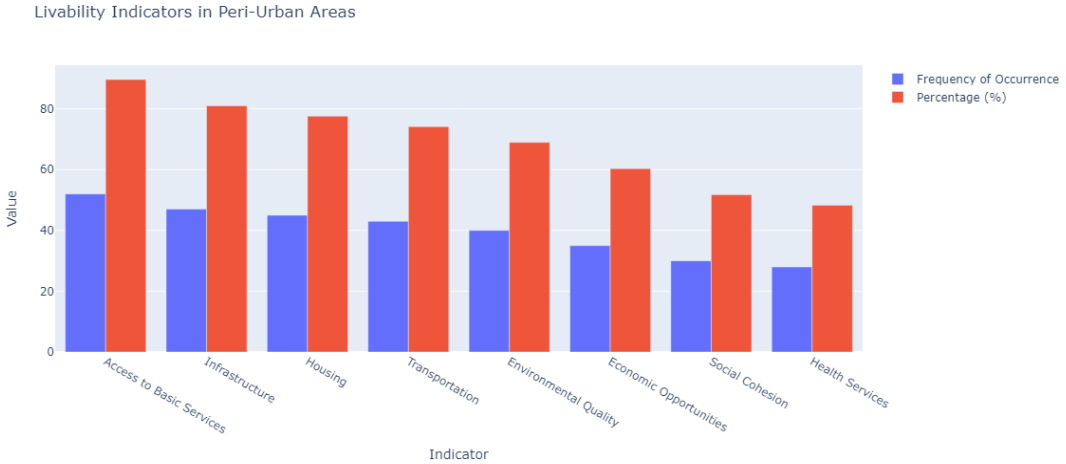

Figure 9. Comparison of metrics by dataset and method

Table 8. Definition and sub-indicators of livability domains

Livability Domain	Description	Example Sub-Indicators
Social Cohesion	Strength of community ties and mutual support	Crime rate, number of community events, and social capital index
Economic Livelihoods	Stability and diversity of income-generating opportunities	Employment rate, informal work ratio, and poverty level
Environmental Health	Quality of the natural and built environment	Air quality index, proximity to green spaces, and flood risk
Basic Infrastructure	Accessibility to essential services	Access to clean water, public transport coverage
Governance & Participation	Inclusiveness and responsiveness of planning processes	Existence of participatory planning forums, land tenure security
Economic Livelihoods	Stability and diversity of income-generating opportunities	Employment rate, informal work ratio, and poverty level

The study of livability indicators and factors for measuring livability and the systematic review of related frameworks of peri-urban areas identifies several – lessons and implications for urban planning and policy making. The review also witnessing that livability in the peri-urban areas is not a simple issue but involves social-economic, environment and infrastructural aspect as well. This has called for multi dimensional assessment frameworks in order to accommodate for this richness. The study aimed at evaluating common indicators of human livability in peri-urban regions and achieved this goal. Opening up basic services was viewed as the most commonly available marker (89.66 per cent), followed by infrastructural (81.03 percent), residential (77.59 percent), and transport (74.14 percent) infrastructures. Other environmental attributes that were highlighted included environmental quality that was mentioned 68.97% of the time. These studies imply that these-factor are important in defining the feasibility of peri-urban regions and should be enhanced in city development policies and plans. The relatively high importance of environmental quality is explained by an increasing concern about the sustainability of development and the role of urbanization and development plays in preserving the environment. To translate these indicators into operable domains, Table 8 provides a summary of the five clustered livability dimensions: social cohesion, economic livelihoods, environmental health, infrastructure access, and governance, with sub-indicators that delineate each domain

Socio economic factors were also specified as explanatory variables and included; economic related factors (60.34%), social related factors (51.72%). This is why policies that advance economic development that is also inclusive as well as community cohesion in peri-urban spaces are desirable. Hence, the review established numerous assessment tools and techniques such as surveys, reviews, rank, and indexing construction. This methodological diversity indicates the need for having general, but manageable assessment tools that may be easily applicable in various settings. Most importantly, the study points out that factors and criteria determining the concept of urban livability are numerous and may differ from one situation to another. This just goes to show that there is a need, nay, a call for the emergence of regional method in answering the questions about livability as well as in the formulation and implementation of policies for making the place better or livable. At the same time attention was paid to the possibility of increasing the level of smart technologies' contribution to the quality of urban life which pointed at an awkward focus as a promising direction for further studies and innovations.

All the above discoveries have some implications for urban planning and policy. First of all, the phenomenon of peri-urban development should be considered from an interdisciplinary angle due to the close connection between distinct indicators of living conditions. Since basic services are rated high, infrastructural development is something that should receive most attention of the peri-urban areas. Environmental quality can only be integrated into urban planning so that sustainable development could be achieved. The current focus on life satisfaction as a measure of residents' perceptions on livability implies the active engagement of the public in case of decision making for Urban Planning and policies. Furthermore, any general solution should not be employed as well. Thus, livability improvement measures should be orientated with the consideration of the concrete features of the identified peri-urban spaces. Last, there is the need to determine if smart technologies pose a viable solution could help enhance the livability of urban centers that may be useful for peri-urban development.

Figure 10 displays the frequency of chosen keywords in Türkiye-based urban studies literature. Although "Peri-urban," "Sustainability," and "Urbanization" occur with high frequency, the term "Urban Livability" is significantly underrepresented, with a frequency count of just 2. This inconsistency indicates a conceptual or terminological lag in Turkish academic discourse about livability, even though it is an important concept worldwide. The results emphasize the importance of including "urban livability" as a known term in national research schemes and bibliometric keyword lists to facilitate more holistic urban policy and planning research.

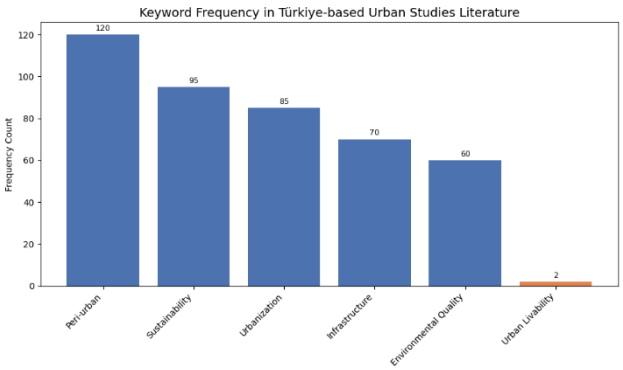

Figure 10. Keyword frequency in Türkiye-based urban studies literature

Policy and Planning Recommendations

Infrastructure Development must adopt scalable, low-cost public transport (e.g., mini-bus rapid transit or bicycle lanes) in peri-urban zones to improve access to jobs and healthcare.

Community Engagement Models must integrate participatory planning tools like community scorecards and digital

feedback platforms to involve residents in urban development.

Smart Technology Applications should utilize IoT sensors and satellite remote sensing for real-time monitoring of water quality, waste management, and land encroachment.

Sustainability Integration must align livability indicators with SDGs, particularly. SDG 11: Sustainable Cities and Communities, SDG 6: Clean Water and Sanitation, SDG 13: Climate Action.

CONCLUSION

This systematic review includes a synthesis of livability indicators and measurement frameworks in peri-urban contexts. The facets of livability highlighted in the current research recapitulate the idea of a multifaceted construct and suggest that evaluations of livability must consider both the population at large and the specific community under consideration. Basic services, infrastructure, shelter, transport are identified as cross-cutting factors that complement the social and economic environment and the environment quality. This (Plus the review also details various forms of methodological approaches employed in livability assessments.) may also point to the fact that there is a need for standardization in frameworks used, yet they should possess the flexibility. This paper also reveals that the use of technology to improve the livability of urban areas could be a very promising area for further study and innovation. These findings may be useful for better understanding the dynamics of peri-urban transformation and improving future urbanization processes to be more efficient, sustainable and inclusive. Subsequent research should continue to draw on comprehensive frameworks for evaluating the over-all livability of peri-urban territories, and investigate novel paradigms for enhancing the quality of life in the continually transforming peri-urban environments. In this way, by exposing the key concerns as well as the potential of peri-urban regions, it is possible to develop more resilient spaces for living, which seek to depart from the polar extremes of the urban and rural domains. The present strategies on peri-urban development life will therefore be comprehensive in dealing with growth and development of the transitional areas.

DATA AVAILABILITY STATEMENT

No data was used for the research described in the article.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest with any individual, institution, or organization in the preparation, evaluation, or publication of this study.

USE OF AI FOR WRITING ASSISTANCE

Not declared.

ETHICS

There are no ethical issues with the publication of this manuscript.

REFERENCES

[1]. K. Ghasemi, M. Hamzenejad, and A. Meshkini, "The spatial analysis of the livability of 22 districts of Tehran Metropolis using multi-criteria decision-making approaches," *Sustainable Cities and Society*, vol. 38, pp. 382–404, 2018, doi: 10.1016/j.scs.2018.01.018.

[2]. H. H. Yassin, "Livable city: An approach to pedestrianization through tactical urbanism," *Alexandria Engineering Journal*, vol. 58, no. 1, pp. 251–259, 2019, doi: 10.1016/j.aej.2019.02.005.

[3]. M. Kashef, "Urban livability across disciplinary and professional boundaries," *Frontiers of Architectural Research*, vol. 5, no. 2, pp. 239–253, 2016, doi: 10.1016/j.foar.2016.03.003.

[4]. J. M. Leach, S. E. Lee, D. V. L. Hunt, and C. D. F. Rogers, "Improving city-scale measures of livable sustainability: A study of urban measurement and assessment through application to the city of Birmingham, UK," *Cities*, vol. 71, pp. 80–87, 2017, doi: 10.1016/j.cities.2017.06.016.

[5]. J. Liu, P. Nijkamp, X. Huang, and D. Lin, "Urban livability and tourism development in China: Analysis of sustainable development by means of spatial panel data," *Habitat International*, vol. 68, pp. 99–107, 2017, doi: 10.1016/j.habitatint.2017.02.005.

[6]. B. Hannah, C. Whitzman, M. Lowe, M. Davern, L. Aye, I. Butterworth, D. Hes, and B. Giles-CortiH., "Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health," *Social Science & Medicine*, vol. 111, pp. 64–73, 2014, doi: 10.1016/j.socscimed.2014.04.003.

[7]. C. Qixian, F. Zheyu, Q. Chunyan, Z. Ye, L. Zihao, and L. Hao. "The urban livability research of Xinyang City based on analytic hierarchy process" *Environment and Development*, vol 31, 01, pp. 19-23, 2019

[8]. "Global Liveability Index 2021 Report | Economist Intelligence Unit," *Economist Intelligence Unit*, Sep. 28, 2023. https://www.eiu.com/topic/liveability (accessed Oct 07, 2024)

[9]. "Press releases," *Mercer.com*, https://www.mercer.com/newsroom/2019-quality-of-living-survey.html?_ga=2.30460095.148581697.1495746400-1918133401.1495743315 (accessed Sept 14, 2024).

[10]. Ease of Living Index 2020, https://smartnet.niua.org/sites/default/files/resources/final_web_ease_of_living_report_2020_.pdf

[11]. Ministry of Housing and Urban Affairs, "Home page | Smartcities," *Smartcities.gov.in*, 2020. https://smartcities.gov.in/

[12]. World Bank, "World Bank Group - International Development, Poverty, & Sustainability," *World Bank*, 2023. https://www.worldbank.org/

[13]. W. Onnom, N. Tripathi, V. Nitivattananon, and S. Ninsawat, "Development of a Liveable City Index (LCI) using multi criteria geospatial modelling for medium class cities in developing countries," *Sustainability*, vol. 10, no. 2, p. 520, 2018, doi: 10.3390/su10020520.

[14]. D. Zhan, M.-P. Kwan, W. Zhang, J. Fan, J. Yu, and Y. Dang, "Assessment and determinants of satisfaction with urban livability in China," *Cities*, vol. 79, pp. 92–101, 2018, doi: 10.1016/j.cities.2018.02.025.

[15]. X. Y. Wang, "Review of the research on Evaluation of Livable City," *Advanced Materials Research*, vol. 476–478, pp. 383–387, 2012, doi: 10.4028/www.scientific.net/amr.476-478.383.

[16]. F. I. Ibrahim, D. Omar, and N. H. N. Mohamad, "Theoretical Review on Sustainable city Indicators in Malaysia," *Procedia - Social and Behavioral Sciences*, vol. 202, pp. 322–329, 2015, doi: 10.1016/j.sbspro.2015.08.236.

[17]. R. Kraushaar, "Review Article: Urban Theory and/or Action?," *Community Development Journal*, vol. 20, no. 1, pp. 58–61, 1985, doi: 10.1093/cdj/20.1.58.

[18]. A. C. Tricco et al., "A scoping review on the conduct and reporting of scoping reviews," *BMC Medical Research Methodology*, vol. 16, no. 1, 2016, doi: 10.1186/s12874-016-0116-4.

[19]. H. Arksey and L. O'Malley, "Scoping studies: towards a methodological framework," *International Journal of Social Research Methodology*, vol. 8, no. 1, pp. 19–32, 2005, doi: 10.1080/1364557032000119616.

[20]. "Better Life Initiative: Measuring Well-Being and Progress - OECD," *www.oecd.org*. https://www.oecd.org/statistics/better-life-initiative.htm

[21]. K. L. Andereck and G. P. Nyaupane, "Exploring the Nature of Tourism and Quality of Life Perceptions among Residents," *Journal of Travel Research*, vol. 50, no. 3, pp. 248–260, 2010, doi: https://doi.org/10.1177/0047287510362918.

[22]. J. Fei, Y. Yang, Y. Jian, W. Cheng, K. Cheng, and Z. Wang, "International comparison of green equality using a benchmarking framework: Insights from 6 global cities," Urban Forestry & Urban Greening, vol. 113, p. 129082, Sep. 2025, doi: 10.1016/j.ufug.2025.129082.

[23]. H. H. Yassin, "Livable city: An approach to pedestrianization through tactical urbanism," *Alexandria Engineering Journal*, vol. 58, no. 1, pp. 251–259, 2019, doi: https://doi.org/10.1016/j.aej.2019.02.005.

[24]. A. Schneider, "Monitoring land cover change in urban and peri-urban areas using dense time stacks of Landsat satellite data and a data mining approach," *Remote Sensing of Environment*, vol. 124, pp. 689–704, 2012, doi: https://doi.org/10.1016/j.rse.2012.06.006.

[25]. I. Duvernoy, I. Zambon, A. Sateriano, and L. Salvati, "Pictures from the other side of the fringe: Urban growth and peri-urban agriculture in a post-industrial city (Toulouse, France)," *Journal of Rural Studies*, vol. 57, pp. 25–35, 2018, doi: https://doi.org/10.1016/j.jrurstud.2017.10.007.

[26]. I. Zasada, W. Loibl, R. Berges, K. Steinnocher, M. Köstl, A. Piorr, A. Werner., "Rural–Urban Regions: A Spatial Approach to Define Urban–Rural Relationships in Europe," *Springer eBooks*, pp. 45–68, 2012, doi: https://doi.org/10.1007/978-3-642-30529-0_3

[27]. A. Allen, "Environmental planning and management of the peri-urban interface: perspectives on an emerging field," *Environment and Urbanization*, vol. 15, no. 1, pp. 135–148, 2003, doi: 10.1177/095624780301500103.

[28]. D. Simon, "Urban Environments: Issues on the Peri-Urban fringe," *Annual Review of Environment and Resources*, vol. 33, no. 1, pp. 167–185, 2008, doi: 10.1146/annurev.environ.33.021407.093240.

[29]. A. G. Aguilar, P. M. Ward, and C. B. Smith Sr, "Globalization, regional development, and mega-city expansion in Latin America: Analyzing Mexico City's peri-urban hinterland," *Cities*, vol. 20, no. 1, pp. 3–21, 2002, doi: 10.1016/s0264-2751(02)00092-6.

[30]. G. Carrus et al., "Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas," *Landscape and Urban Planning*, vol. 134, pp. 221–228, 2014, doi: 10.1016/j.landurbplan.2014.10.022.

[31]. J.D. Miller, H. Kim, T. R. Kjeldsen, J. Packman, S. Grebby, and R. Dearden, "Assessing the impact of urbanization on storm runoff in a peri-urban catchment using historical change in impervious cover," *Journal of Hydrology*, vol. 515, pp. 59–70, 2014, doi: 10.1016/j.jhydrol.2014.04.011.

[32]. F. Wu, F. Zhang, and C. Webster, "Informality and the development and demolition of urban villages in the Chinese peri-urban area," *Urban Studies*, vol. 50, no. 10, pp. 1919–1934, 2012, doi: 10.1177/0042098012466600.

[33]. I. Duvernoy, I. Zambon, A. Sateriano, and L. Salvati, "Pictures from the other side of the fringe: Urban growth and peri-urban agriculture in a post-industrial city (Toulouse, France)," *Journal of Rural Studies*, vol. 57, pp. 25–35, 2017, doi: 10.1016/j.jrurstud.2017.10.007.

[34]. A. Liberati, "The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration," *Annals of Internal Medicine*, vol. 151, no. 4, p. W-65-94, 2019, doi: https://doi.org/10.7326/0003-4819-151-4-200908180-00136

[35]. J. López Belmonte, A.-J. Moreno-Guerrero, J. A. López Núñez, and S. Pozo Sánchez, "Analysis of the Productive, Structural, and Dynamic Development of Augmented Reality in Higher Education Research on the Web of Science," *Applied Sciences*, vol. 9, no. 24, p. 5306, 2019, doi: https://doi.org/10.3390/app9245306

[36]. H. Shokravi, H. Shokravi, N. Bakhary, M. Heidarrezaei, S. S. Rahimian Koloor, and M. Petrů, "Application of the Subspace-Based Methods in Health Monitoring of Civil Structures: A Systematic Review and Meta-Analysis," *Applied Sciences*, vol. 10, no. 10, p. 3607, 2020, doi: https://doi.org/10.3390/app10103607

[37]. D. Węziak-Białowolska, "Quality of life in cities – Empirical evidence in comparative European perspective," *Cities*, vol. 58, pp. 87–96, 2016, doi: 10.1016/j.cities.2016.05.016.

[38]. A. Mishina, D. Andreyuk, and W. Xu, "Life values in Russia and China: Semantic analysis and comparison," *BRICS Journal of Economics*, vol. 5, no. 3, pp. 141–162, 2024, doi: 10.3897/brics-econ.5.e129880.

[39]. C. Prapas and V. Mavreas, "The Relationship Between Quality of Life, Psychological Wellbeing, Satisfaction with Life and Acculturation of Immigrants in Greece," *Culture Medicine and Psychiatry*, vol. 43, no. 1, pp. 77–92, 2018, doi: 10.1007/s11013-018-9598-3.

[40]. A. M. Rose, "Urbanism and Suburbanism as Ways of Life: A Re-evaluation of Definitions," Human Behavior and Social Processes, pp. 641–664, 2013, doi: 10.4324/9781315008196-42.

[41]. K. Wyndham, "Suburbs, Inc.: Exploring Municipal incorporation as a mechanism of racial and economic exclusion in suburban communities," *RSF the Russell Sage Foundation Journal of the Social Sciences*, vol. 9, no. 2, pp. 226–248, 2023, doi: 10.7758/rsf.2023.9.2.10.

[42]. M. Kashef, "Urban livability across disciplinary and professional boundaries," *Frontiers of Architectural Research*, vol. 5, no. 2, pp. 239–253, 2016, doi: https://doi.org/10.1016/j.foar.2016.03.003.

[43]. A. Kovacs-Györi, P. Cabrera-Barona, B. Resch, M. Mehaffy, and T. Blaschke, "Assessing and Representing Livability through the Analysis of Residential Preference," *Sustainability*, vol. 11, no. 18, p. 4934, 2019, doi: 10.3390/su11184934.

[44]. A. Oppio, M. Bottero, and A. Arcidiacono, "Assessing urban quality: a proposal for a MCDA evaluation framework," *Annals of Operations Research*, vol. 312, no. 2, pp. 1427–1444, 2018, doi: 10.1007/s10479-017-2738-2.

[45]. A. Nelson, "The praxis of sustainability citizenship," *RMIT Research Repository (RMIT University Library)*, pp. 17–28, 2016, doi: 10.4324/9781315678405-11.

[46]. G. R. Patil and G. Sharma, "Urban Quality of Life: An assessment and ranking for Indian cities," *Transport Policy*, vol. 124, pp. 183–191, 2020, doi: 10.1016/j.tranpol.2020.11.009.

[47]. Y. Cheng, Y. Wang, Z. Wang, N. Du, Y. Sun, and Z. Zhao, "Spatio-temporal dynamic of quality of life of residents, Northeast China," *Chinese Geographical Science*, vol. 26, no. 5, pp. 623–637, 2016, doi: 10.1007/s11769-016-0827-9.

[48]. M. Arefi and N. Nasser, "Urban design, safety, livability, & accessibility," *URBAN DESIGN International*, vol. 26, no. 1, pp. 1–2, 2021, doi: 10.1057/s41289-021-00155-9.

[49]. S. R. Younes, B. Marques, and J. McIntosh, "Public Spaces for Older People: A Review of the Relationship between Public Space to Quality of Life," *Sustainability*, vol. 16, no. 11, p. 4583, 2024, doi: 10.3390/su16114583.

[50]. A. Cárcaba, R. Arrondo, and E. González, "Does good local governance improve subjective well-being?," *European Research on Management and Business Economics*, vol. 28, no. 2, p. 100192, 2022, doi: 10.1016/j.iedeen.2021.100192.

[51]. X. Xie, H. Sun, J. Gao, F. Chen, and C. Zhou, "Spatiotemporal differentiation of coupling and coordination relationship of Tourism–Urbanization–Ecological Environment system in China's major tourist cities," *Sustainability*, vol. 13, no. 11, p. 5867, 2021, doi: 10.3390/su13115867.

[52]. D. Liu, C. Zhang, and H. Yu, "Comprehensive evaluation of urban livability," *Journal of Physics Conference Series*, vol. 1345, no. 3, p. 032051, 2019, doi: 10.1088/1742-6596/1345/3/032051.

[53]. M. Kashef, "Urban livability across disciplinary and professional boundaries," *Frontiers of Architectural Research*, vol. 5, no. 2, pp. 239–253, 2016, doi: 10.1016/j.foar.2016.03.003.

[54]. T. P. Pasanen et al., "What makes a liveable neighborhood? Role of Socio-Demographic, dwelling, and environmental factors and participation in Finnish urban and suburban areas," *Journal of Urban Health*, vol. 101, no. 6, pp. 1207–1220, 2024, doi: 10.1007/s11524-024-00927-y.

[55]. D. Antonescu, "Liveable City from an Economic Perspective," *Journal of Urban and Landscape Planning*, no. 2, pp. 49–62, 2017, doi: 10.54508/julp.02.02.

[56]. D. Zhan, M.-P. Kwan, W. Zhang, J. Fan, J. Yu, and Y. Dang, "Assessment and determinants of satisfaction with urban livability in China," *Cities*, vol. 79, pp. 92–101, 2018, doi: 10.1016/j.cities.2018.02.025.

[57]. "Remarks by the President Upon Arrival in New York." https://clintonwhitehouse3.archives.gov/WH/New/html/19990921.html

[58]. A. Paul, "Developing a methodology for assessing livability potential: An evidence from a metropolitan urban agglomeration (MUA) in Kolkata, India," Habitat International, vol. 105, p. 102263, Oct. 2020, doi: 10.1016/j.habitatint.2020.102263.

[59]. "Search Census data | Australian Bureau of Statistics," *Abs.gov.au*, 2021. http://www.abs.gov.au/websitedbs/censushome.nsf/home/map (accessed Sept 27, 2024).

[60]. S. E. Bibri and J. Krogstie, "Generating a vision for smart sustainable cities of the future: a scholarly backcasting approach," European Journal of Futures Research, vol. 7, no. 1, Aug. 2019, doi: 10.1186/s40309-019-0157-0.

[61]. P. Evans, "Livable cities: Urban struggles for livelihood and sustainability", *University of California Press*, 2002

[62]. S. Shamsuddin,, J. D. Jibril,, and R. M. Nor, "Conceptual framework for assessing livability in Malaysia", In Proceedings of the 2012 *International Conference on Statistics in Science, Business and Engineering*, pp. 1-6. 2012

[63]. EIU digital solutions, "Liveabililty Ranking and Overview August 2012", The Economist Intelligence Unit, https://www.eiu.com/public/topical_report.aspx?campaignid=liveability2012 (accessed Aug 18, 2024).

[64]. "Vienna tops Mercer's 20th Quality of Living ranking," www.mercer.com. https://www.mercer.com/newsroom/2018-quality-of-living-survey.html (accessed Sept 28, 2024).

[65]. AARP. The AARP Livability Index. 2015. https://www.aarp.org/livable-communities/about/info-2014/livability-index.html

[66]. S. Angel, S.C. Sheppard, D.L. Civco, "The Dynamics of Global Urban Expansion", *World Bank, Transport, Urban Development Department: Washington*, DC, USA, 2005.

[67]. S. Wolff, M. V. Mdemu, and T. Lakes, "Defining the Peri-Urban: A Multidimensional Characterization of Spatio-Temporal Land Use along an Urban–Rural Gradient in Dar es Salaam, Tanzania," *Land*, vol. 10, no. 2, p. 177, 2021, doi: https://doi.org/10.3390/land10020177.

[68]. Q. Weng, T. Esch, P. Gamba, D. Quattrochi, and G. Xian, "Global Urban Observation and Information: GEO's Effort to Address the Impacts of Human Settlements," *Taylor & Francis series in remote sensing applications*, pp. 15–34, 2014, doi: https://doi.org/10.1201/b17012-4.

[69]. Y. Buehler, "Mapping urban and peri-urban agriculture using high spatial resolution satellite data," Journal of *Applied Remote Sensing*, vol. 3, no. 1, p. 033523, 2009, doi: https://doi.org/10.1117/1.3122364.

[70]. S. Kumar, V. Singh, Jitender Saroha, and Kamal Upreti, "The physical landscape and livelihood activities in the Sarbarikhad watershed of Himachal Pradesh," *AIP conference proceedings*, vol. 2821, pp. 140002–140002, 2023, doi: https://doi.org/10.1063/5.0150414.

[71]. R. Liu, J. Shi, X. Chen, and C. Lu, "Network anomaly detection and security defense technology based on machine learning: A review," *Computers & Electrical Engineering*, vol. 119, pp. 109581–109581, 2024, doi: https://doi.org/10.1016/j.compeleceng.2024.109581.

[72]. S. Alipour and A. Meshkini, "Dream housing: Exploring effective factors on housing livability in the neighborhood from the perspective of residents," *Environmental Development*, vol. 52, p. 101067, 2024, doi: https://doi.org/10.1016/j.envdev.2024.101067.

[73]. T. Schimanski, A. Reding, N. Reding, J. Bingler, M. Kraus, and M. Leippold, "Bridging the gap in ESG measurement: Using NLP to quantify environmental, social, and governance communication," *Finance Research Letters*, vol. 61, p. 104979, 2024, doi: https://doi.org/10.1016/j.frl.2024.104979.