# The Indicators and Methods used for Measuring Urban Liveability: A Scoping Review

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**Research**

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# Abstract

Purpose Livability is a multi-dimensional and hierarchical concept which consists of various criteria and sub-criteria and may be evaluated in different ways. The aim of this study was to systematically review indicators and methods used for the evaluation of urban liveability in literature.

Methods The five-stage methodological framework of Arksey and O'Malley was used to conduct this scoping review. A systematic search of electronic databases, including Scopus, Medline (via PubMed), EMBASE, Web of Science and Ebsco was done until May 29, 2019. Web searching, searching reference lists and hand searching was also conducted to retrieve more relevant articles. Two reviewers screened the papers for eligibility based on the inclusion criteria and extracted their key data and reported them descriptively.

Results Sixty seven (67) out of 3599 papers met the selection criteria. This review showed 5 distinct domains considered to be important components of liveability. The domains were Economical, Environmental, Institutional, Social, and Governance (Political). The most important indices which were frequently applied in various studies were Environmental friendliness and Sustainability, Socio-Cultural Conditions and Economic Vibrancy and Competitiveness. We also identified 10 different methodologies used for assessing urban liveability.

Conclusion This paper discusses and summarizes the latest indicators and methods used for determining urban liveability. The information offered in the review can help future investigators measure urban liveabilty more systematically than before.


# 1. Introduction

Livability is an “ensemble concept” with no precise or universally agreed-upon definition. It is multi-dimensional and hierarchical and consists of various criteria and sub-criteria that may be determined in various ways [1]. The definition of livability may differ from one culture to another and from time to time, as the concept is relative, and its “precise meaning depends on the place, time, and purpose of the assessment and on the value system of the assessor”. Livability can be broad or narrow depending on the context; and studies, organizations and authorities around the world have had their own unique definitions [1]. Livability provides opportunities for all local communities with different values, and makes them better places to work, live and grow [2]. A liveable urban environment refers to a place where the built structure promotes quality of life by supporting the basic needs of its residents. The founding premise is that the urban form and environment, the economic values, and social sustainability are interconnected and that cities should be comprised of a built landscape that encourages, rather than impedes healthy and sustainable living [1].

Selecting the indicators for measuring livability is of paramount importance in investigating urban livability. The complexity of the concept of livability and its parameters makes it difficult to assess [3]. Also our understanding about these concepts is not steady , and may change over time and in different contexts .[4] Numerous previous studies have considered different variables and indicators for measuring liveability [5] such as social, economic, physical and environmental factors. For example, a case study in Australia, assessed urban livability in 11 specific domains, involving natural environment, crime and safety, education, employment and income, health and social services, housing, leisure and culture, local food and other goods, public open space, social cohesion and local democracy, and transport [6]. In another case study on urban livability in China in 2019, objective indicators such as social civilization, economic development, environmental health, resources sustainability, living amenity and public safety were considered [7]. In addition, many organizations also focused on ranking livable cities using different evaluation criteria. For instance, the Economist Intelligence Unit's (EIU) Global Livability rankings incorporated 30

qualitative and quantitative indicators from 5 dimensions of stability, healthcare, culture and environment, education, and infrastructure [8], whereas the Merce's Quality of Living rated livability according to 39 factors grouped in 10 dimensions, including political and social environment, economic environment, sociocultural environment, medical and health considerations, schools and education, public services and transportation, recreation, consumer goods, housing, and natural environment [9]. Although the scope and contents of urban liveability indicators may differ from one project to another [10], in general, researchers believe these individual indicators should be simple, elegant, effective, sensitive to change, measurable and verifiable (preferably in a standardized way), conceptually sound, understandable, unambiguous, objective and drawn upon data that either exist or is relatively easy to obtain **.[4]** Despite the ongoing debates about assessing urban livability there is still a lot of similarity among the indicators used for this evaluation [11], but still there are no simple techniques that can be used to compare liveability across countries and time periods [10].

Despite the attention that urban livability has received and the sophistication of the available methods, it is still not well understood how accurate (or not) the various methods are .[4] The results of a systematic review in North America, Europe and Australia showed different ranking methods have been used by different organizations, including: Economist Intelligence Units( EIU) livability ranking, Mercer quality of living survey, Organization for Economic Cooperation and Development Better Life Index (OECD BLI) [3]. Some other systematic reviews have been performed in various countries such as China [12], Malaysia[13], the US[14] and Australia[6]. The chosen urban liveability assessment method is important, because different results can be obtained from the same data, if different assessment methods are used [4].

More evidence has emerged about urban livability in recent years, and previous systematic reviews have reached different conclusions. However, there is still no unified definition for evaluating urban livability in the literature. A new scoping review is therefore required for identifying the areas that have already been included and fulfilled, and the areas that need improvement. In this review we focused on two main objectives. First, we investigated the indicators for evaluating urban livability and the key variables which researchers have used in these researches. Second, we reviewed the methods and approaches to determine urban livability criteria. Our final goal was to achieve a summary of indicators and methodologies used in urban livability studies.

# 2. Method Of The Review

The Arksey and O'Malley methodological framework [15] was adopted for conducting this scoping review. The aim of this framework is to map the key concepts underpinning a research area, and the main sources and types of evidence available. The framework has five stages, including:

### 2.1 Stage 1: Identifying the research question

Our research question was: What is in the existing literature about the indicators and methods for measuring urban liveability?

### 2.2 Stage 2: Identifying the relevant studies

The search strategy was developed by ZK and TY (the first and second author) under the supervision of AM (the third author). A three-step search strategy was utilized in this scoping review. An initial search of all identified keywords and index terms was undertaken across five electronic databases including Scopus, Medline (via PubMed), EMBASE, Web of Science and Ebsco. Then, using thesauri such as medical subject headings (mesh) and emtery, we extracted appropriate and suitable keywords for the concepts; and then depending on the database, the appropriate search

strategy was developed. The search strategy in each database is presented in Appendix 1. In the next step, we searched the databases from 1980 through to May 29, 2019, without language restrictions.

A second search was also conducted in Google Scholar, and the 10 first pages of the search results were inspected to ensure that the relevant articles were retrieved. The reference list or bibliographies of all relevant papers and reports of existing networks, relevant organizations and conferences were also searched to maximize the sensitivity of our search. The references identified were then downloaded into an EndNote database and imported into a Microsoft Excel spreadsheet, to check for duplications and do initial screening.

### 2.3 Stage 3: Study selection

Inclusion criteria were studies reporting urban liveability indices. No limitations were placed on the type of report (published, unpublished, briefs, conference presentations, etc.). No language limitation was imposed. We included all different research designs. Screening of articles was done in two stages. The first stage the title and abstract were reviewed and the article was retained, if they mentioned indicators and/or methods in relation to urban liveability. Two reviewers (ZK and TY) independently screened the titles and abstracts of the studies. In the case of disagreement, inconsistencies were resolved through discussion and referring to another author (NK), to make the final decision.

At the second stage of screening, the full-text of articles was evaluated and tighter restrictions were applied and articles were included if the indicators and the method of evaluating urban liveability were mentioned.

For the articles whose abstract or full-text was not available, the corresponding and/or other authors were contacted via email. We did not exclude articles based on their quality, since the methodology of applying these criteria has not been developed yet [15].

### 2.4 Stage 4: Extracting the data

Extracted information was summarized in two tables. The first table (Table 1) included the first author, publication year, country or city where the research took place, data source, number of baseline indices, indices for evaluation of urban liveability, number of baseline Indicators, indicators for evaluation of urban liveability, and the purpose of their study.

The second table (Table 2) included the language of the article (English, Chinese or other), and the technique and evaluation model used for urban liveability. Assessment of methodological quality and risk of bias was not performed according to the instructions for scoping reviews [15].

### 2.5 Stage 5: Collating, summarizing, and reporting the results

The final stage of a scoping review involves collating, summarizing and reporting the results. According to Arksey and O'Malley, a framework should be used to collate results. We created a data table for study characteristics. From these tables we compared characteristics, setting, and indicators across all studies to answer our first research question. Second, Articles were evaluated in terms of different indicators and the most commonly used indicators were identified in each scope. Third, we reviewed each study and identified the methods used for evaluation of urban liveability. We

created a data table and graph which contained evaluation methods from each study, in different times (between 2000 and 2019). Finally, the most commonly used indicators and methods for determining urban liveability were discussed.

# 3. Results

## 3.1 Overview

Out of 3599 articles retrieved from electronic databases, 60 were eligible for doing a full-text review; and 7 citations were identified by a comprehensive backward and forward reference search. Finally 67 studies were included in the full text review (Figure 1). Of these 67 articles, 48 % (32 articles) were in Chinese and the rest were in English. 54% (36 articles) of the studies were conducted between 2015 and 2019 (Figure 2). About 82 % (55 articles) had been done in the recent 10 years. Table 1 presents the characteristics of each included study.

Out of the 67 studies, 44 were from China; three from Australia; four from Iran; three from India; three from Malaysia; two from Taiwan; two from European cities; and one each from North America and United Kingdom, Spain, Italy, Thailand, Abu Dhabi, Singapore and Macedonia. The included studies were published over a 19-year period between the years of 2000 and 2019. In order to do a conceptual analysis, the focus was on common indicators and unique methods. The included studies used various indicators such as population demographics, employment, public services, urban environment, crime safety, health and public safety, social culture and other indicators. More details are presented in Table 1 and figure 3. The included studies used various methods and evaluation models including qualitative and quantitative methods (Figure 4 and Table 2).

## 3.2 Indicators for Evaluation of urban liveability

The literature review identified a diverse range of indicators related to urban liveability. The data were inquired from a variety of sources including national surveys, digital elevation models, statistical yearbooks, Environmental Protection Agency data, and literature on particular aspects of liveability such as transport, climate, economics or the health of urban environments. These indicators make up the evaluation indicator system.

Table 1 presents a summary of the number of indices and indicators and a full list of the indicators in each study. Safety and security, crime, climate, transportation, infrastructure, healthcare, public policy and services, business environment, cost of living, education, housing, recreational amenities, gross domestic product (GDP) per capita, sanitation, culture, air pollution have been incorporate into a quantitative model to compare and rank cities for urban liveability. The indicators reviewed included subjective and objective measures. Objective indicators used existing or routinely collected data that measured concrete facts, such as GDP per capita, employment rate, number of beds in hospitals per 10000 population and etc. Subjective indicators measured people's behaviors, beliefs and perceptions about their local environment, such as wellbeing, satisfaction, walkable places and public security. These indicators have been grouped and applied at three levels: individual-level measures, social or environmental level and policy-level measures.

The research team grouped indicators into 5 main domains. The domains were: 1) Economic Vibrancy and Competitiveness: Economic Performance , Economic Openness and Infrastructure, 2) Environmental Friendliness and Sustainability: Pollution, Depletion of Natural Resources and Environmental Initiatives, 3) Domestic Security and Stability: Crime Rate, Threats to National Stability and Civil Unrest, 4) Socio-Cultural Conditions: Medical and

Healthcare, Education and Housing, Sanitation and Transportation, Income Equality and Demographic Burden and Diversity and Community Cohesion, 5) Political Governance: Policymaking and Implementation, Government System, Transparency and Accountability, Corruption. Further details on the subset indicators of each index can be found in referenced articles.

The studies were also grouped based on the city in which the study was conducted. Figure 3 presents the distribution of indicators in the studies from the same country. Most urban liveability studies were done in China (47.7%). In all studies of urban liveability in China, Environmental Friendliness and Sustainability indicators were used; and Socio-Cultural Condition indicators were used in 93% of them. Also, 82% of Chinese studies used Economic Vibrancy and Competitiveness indicators in urban liveability. These 3 indices and their associated indicators were the most commonly used, in our included studies.

### 3.3 Evaluation Model of urban liveability

Ten categories of evaluation models were used in the included studies. Qualititative Delphi methods, Analytical hierarchy process (TOPSIS and entropy), cluster analysis method, Factor analysis & Principle Component Analysis, GIS and spatial modeling, Economist Intelligence Unit & Mercer city rankings, comprehensive marking or standard method, the livable level integrated index, neural networks and GLCI. The summary of these key evaluation models and techniques for determining urban liveability, are in Table 2. From the 67 articles identified, 19 (23.38%) used qualitative and the rest of the studies used quantitative methods to evaluation urban liveability. The qualitative methods of evaluating urban liveability were used between 2000 to 2004 [16]. Among the quantitative methods, 4 methods accounted for 63.3% of the articles. These methods were the Analytical hierarchy process and entropy (AHP; N = 22; 26.8%), Factor analysis & Principle Component Analysis (FA & PCA; N = 12; 14.6%), GIS and spatial modeling (GIS; N = 12; 14.6%) and the Economist Intelligence Unit & Mercer city rankings Model (EIU & Mercer; N = 6; 7.3%). 4 (4.87%) studies used GLCI, 3 (3.65%) studies used cluster analysis methods, and 2 (2.4%) studies used comprehensive marking or standard method. The livable level integrated index and neural networks were each used in one article.

A summary of the included studies classified by year and type of the liveability evaluation model is shown in figure 4. Between 2015 and 2019, about 20 (47.7%) of articles used the Analytical hierarchy process method and GIS and spatial modeling for evaluation of urban liveability.

## 4. Discussions

Scoping reviews are used to map or configure a body of evidence. This scoping review about the domains, indicators and evaluation models of urban liveability can be used in designing and planning urban structures, and improving the quality of life of urban residents, by urban health planners and policy-makers. In this review, we focused more on breadth, and included studies that showed the variation of assessing methods, rather than focusing on each domain in detail.

The review suggests that there are a large number of indicators that can be used in ranking cities for liveability. The 5 domains of urban liveability are an important base for researchers wishing to add new indices and indicators to the indices already mentioned in the literature. Each of these indexes includes a list of indicators that has been mentioned in our tables.

In this review, the most common indicators used in various studies for assessing urban liveability were identified. Environmental Friendliness and Sustainability, Socio-Cultural Conditions and Economic Vibrancy and Competitiveness were the most frequently applied indices. These indicators have been used at national, state, and local levels to compare the liveability of cities and regions. Tan et al (2018) set 121 indicators in 5 economic, environmental, institutional, social and governance and political indices for ranking the livability of large world cities [17]. Cheng (2019) has also established evaluation indicators from social civilization, economic development, environmental health, resources sustainability, living amenity and public safety [7]. Liao et al (2019) created their evaluation system for 20 cities in China from 4 domains including, economic development, population situation, resources and environment [18].

Liveability indicators can be useful for monitoring progress towards achieving policy reform, engaging governments in conversation with the private and community sectors, and enhancing the connection between urban planning and public health [19]. Indicators are important because they provide benchmarks against which to monitor progress towards policy reform; and to make comparisons between and within cities. More effective and consistent use of liveability indicators is required to promote healthy, liveable and sustainable cities, and can be achieved through integrated planning across and between governments, economic infrastructure, health care, environmental protection agencies, educational facilities, and cultural and welfare organizations.

Indicators may vary with geographical locations or cultural values, and this may limit the generalization of our results. Indicators of liveability may measure progress towards achieving a wide range of health policy outcomes, including enhanced health and reduced inequalities. Although many indicators for urban liveability were identified in this review, the majority require further development, before they can be operationalized and link to health datasets. In order to validate liveability indicators, consideration should also be given to testing the association between these indicators and health. This can be achieved by linking indicators measured at an appropriate scale to existing health datasets. There is also a need to create liveability indices that are robust and related to urban planning policies [6].

Different experts or organizations have proceeded from different perspectives and used different evaluation systems for assessing urban livability. In the present review, ten different methodologies were used for evaluating urban livability. More than half of the articles had used one of the four evaluation models which were the AHP and entropy, FA and PCA, GIS and spatial model, EIU and Mercer Model.

In this scoping review, 22 studies used the AHP method (TOPSIS and entropy) for evaluating liveability. AHP is a multi-criteria decision-making method which has been extensively utilized in a wide variety of areas. In this method, both quantitative and qualitative criteria can be transformed into numerical scales, and this facilitates the users' understanding about the factors chosen for evaluation, as well as their relative importance in relation to one another [1]. AHP can assist the decision maker in effectively summarizing and assessing all information, defining the right questions and determining the optimum and most appropriate solutions. This method is applied to estimate the weights of parameters, because it has a simple hierarchical structure, sound mathematical basis, widespread usage, and ability to measure inconsistencies in judgements. In the process of AHP, pair-wise comparison matrices of each factor and sub-factors are implemented through consultation with experts who have field experience [10]. Generally, the AHP technique can be described through three major stages: (1) structuring a complex problem in the form of a simple hierarchy; (2) comparing decision elements using the pairwise method; and (3) computing the relative weights of decision elements [20]. This technique is, in accord with the fundamental principles of livable and ecological assessment of a city, via building up a multi-layer criteria system and allocating a standard value and numerical weight to each criterion, through mathematic calculation, to finally obtain numerical priorities, to determine if a city has reach the standards of being livable [21].

You, 2008, Luo, 2009, and Liu, 2017, Liao, 2019 and Tao, 2019 have all adopted the Factor analysis method into their livability evaluation[5, 18, 22-24] ; and Li, 2010, Saitluanga, Benjamin L 2014, Wu, 2017 and Marsal-Llacuna, M(2015), have all adopted the principal component analysis method into their livability evaluation[25-28]. Factor analysis is one of the most preferred approaches for measuring urban socio-spatial differentiation. The principal component analysis is a special case of factor analysis; the technique is a multivariate data reduction method that derives a composite, or a smaller set of variables from a large set of variables. Each of the new set of variables may be thought as a super variable that represents a cluster of highly correlated variables and is able to reveal the patterns of liveability within the city [26].

Jia, 2017, Sofeska, 2017, Yin, 2018, Zhan, 2018 have adopted the GIS and spatial model into their livability evaluation. GIS can skillfully translate some difficult features that people can't handle directly. The development of communities is partly related to their spatial location. Studies have shown that people's understanding of the actual distance is affected by social background and life experience and people with different backgrounds may have different criterions for judging distance. However, in GIS, the spatial analysis can measure straight line or walk distances accurately, and this precludes inconsistent results. Generally, GIS is very good at dealing with space and location issues [29-32].

Zhao et. al. used neural networks to assess urban liveability. The neural network is a method based on artificial intelligence, which can adjust the inter-relations among the internal nodes to process final results [33]. Other authors such as Tan used the GLCI method to evaluate urban liveability in 2014, 2016 and 2018. This method can be applied to all cities around the world. Also its results are consistent with results the Economist Intelligence Unit & Mercer city rankings and methods [34-36].

Some of the unique methods used in our included studies were probably related to the year in which the theory was introduced. Therefore, we also reported the time periods which different studies were conducted in. Another explanation for the use of some methods might be that those methods were just more popular or methodologically sounder or easier to conduct. However, the methods that are used more frequently, may not necessarily be the best methods, and may have been selected due to lack of awareness about better methods. The popularity of this methods may not have been related to their quality, but instead because of fashion, familiarity or prior training [37].

We suggest aligning and comparing future indicators against the existing urban planning policies. Building on these findings, the next step in this research is to improve and develop a set of liveability indicators that are robust, evidence-based and linked to urban planning policies. Identifying the methods which has been done in this review is just the first step in a much larger and ongoing work aimed at improving the methods and the scientific rigor for assessing urban liveability. We hope that this review will help to increase awareness among planners and researchers about the indicators and methods related to urban liveability. But what is more important is to identify the factors and processes that create and affect liveability, and improve the situation of world cities.

# 5. Conclusions

This scoping review identified five main domains of indicators for measuring urban liveability. These domains include: Economic, Environmental, Domestic Security, Socio-Cultural and Political/Governance domains. Moreover, ten methods were identified that could be applied to evaluating liveability and help improve urban development. Although many indicators and methods of urban liveability were identified in this review, the majority require further development, before they can be operationalized and used consistently by health planners and policy-makers.

# 6. Declarations

## Abbreviations

EIU: Economist Intelligence Unit's; OECD BLI: Organization for Economic Cooperation and Development Better Life Index; GDP: gross domestic product; GLCI: Global Liveable City Index; GIS: Geographic Information System; FA: Factor analysis; PCA: Principle Component Analysis; AHP; Analytical hierarchy process.

## Ethical Approval and Consent to participate

This study was approved and registered by the Code of Ethics (IR.KMU.REC.1398.232).

## Consent for publication

Not applicable.

## Availability of supporting data

Not applicable.

## Competing interests

The authors declare that they have no competing interests.


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## Authors' contributions

ZK conceived the study and every one authors identified key literature to be included within the review. ZK led the drafting of the manuscript and key discussion points with support from TY, NK and AM. NK managed the planning of the tables (with feedback from all authors), and management of references. All authors provided important intellectual contribution and guidance throughout the event of the manuscript. MM and MMF provided guidance on the presentation of the findings and guidance on final revisions. All of the authors contributed to criticism and revisions to the manuscript, agreeing on the ultimate version.


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# Tables

Table 1: Characteristics of included studies and the indexes and indicators used in each study

| :ion | Country or city | Data source | No. of baseline Index | Indexes for Evaluation of urban Liveability | No. of baseline Indicators | Indicators for Evaluation of urban Liveability | Purpose |
|---|---|---|---|---|---|---|---|
| ] | Nanjing city, China | survey data (1998) and results from joint investigations, conducted by the Construction Department of Jiangsu Province and the Yangtze Evening Post (1993,1998) | 5 indexes | 1.quality of buildings<br><br>2.environmental security<br><br>3.landscape planning<br><br>4.public services<br><br>5.community cultural environment | 56 indicators | 1.(a. building design, b. ventilation, c. structure, d. storeroom, e. maintain service, f. electricity, g. storey height, h. fireproofing, i. sound insulation, j. daylighting, k. insulation protection, l. indoor temperature, m. pipeline, n. sanitary fixture, o. convenient kitchen, p. channel)<br>2.(a. air quality, b. drinking water quality, c. noise pollution, c. flood inundation, d. vital communication line, e. dumping site, f. chemical industry, g. polluted water, h. flammable and explosive substance)<br>3.(a. courtyard, b. building density, c. natural landscape, d. building interval, e. greening, f. leisure | Point out the development stage of living quality and put forward schemes to optimize the human settlement environment |

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| | | | | | | square, g. architectural style) 4.(a. commercial network, b. medical and health care, c. food market, d. power supply system, e. telecommunication service, f. water supply system, g. drainage system, h. schools, i. public parking plot, j. cultural and recreational facilities) 5.(a. neighborhood harmony, b. community security, c. characteristic features of residence, d. achievement of community, e. living near relatives and friends, f. living near schools, g. floating population, h. living far from shantytown, i. civic square, j. sense of belonging) | |
| ] | North American and United Kingdom | principal qualitative and quantitative data input of the health check | 9 indexes | 1.population demographics 2.employment 3.retail vacancy | 16 indicators | Null | the concept of ‘city-centre livability’ and how it can be measured through a set of key performance indicators. |

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| | | | | 4. performance and sales<br>5. car parking<br>6.footfall<br>7.crime safety<br>8.cleanliness<br>9. tourism and evening economy | | | |
| [39] | Null | Null | 6 indexes | 1.economic development degree<br>2.degree of social harmony<br>3.culture richness<br>4.habitability<br>5.pleasant landscape<br>6.public security | 41 indicators | 1.(a. economic aggregate, b. economic structure, c. economic benefit, d. developing costs, e. science and education, f. innovation ability)<br>2.(a. political situation stability, b. income distribution, c. employment situation, d. social insurance, e. living guarantee, f. social security coverage rate)<br>3.(a. historic landmarks and sites, b. traditional art, c. folk custom, d. educational facilities, e. sports field, f. recreational facilities, g. value orientation, h. moral | Proposes six standards of judging the livable city and explains some general principles of the development of the livable city |

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| | | | | | | cultivation, i. cultural activity)<br>4.(a. ecological residence, b. neighborhood relations, c. living facilities, d. consumption level, e. living space, f, health care, g. traffic facility, h. communication facility, i. service facility)<br>5.(a. contamination control, b. greening rate, c. waste treatment, d. natural landscape, e. artificial landscape, f. integrated landscape)<br>6.(a. climatic disaster prevention, b. geological disaster prevention, c. accident, d. public health, e. social security) | |
| ] | Null | Null | 5 indexes | 1.security<br>2.health<br>3.facility<br>4.convenience | | 1.(a. crime rate, b. traffic accident rate, c. emergency shelter, d. satisfaction with security)<br>2.(a. air pollution index, b. garbage | Reviewed the research development of the Livable City, and built evaluative framework of 5 index systems |

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| | | | 5.amenity | | disposal rate, c. noise, d. drinking water standard, satisfaction with environmental health)<br>3.(a. number and rating of educational facility, b. number and rating of medical facility, c. number and rating of commercial facility, d. number and rating of recreational facility, e. number and rating of children’s playground, f. satisfaction with facilities)<br>4.(a. number and rating of transport facility, b. number and rating of traffic route, c. distance to city center, d. satisfaction with travel)<br>5.(a. number and rating of parks and green space, b. greening rate, c. open space, d. building density, e. building altitude, f. the history of blocks, g. | |

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|---|---|---|---|---|---|---|---|
| | | | | | | satisfaction with amenity) | |
| ] | Dalian, China | survey data (2006) | 5 indexes | 1.convenience<br>2.security<br>3.pleasure<br>4.facility<br>5.health | 33 indicators | 1.(a. retail, b. shopping facility, c. dining facility, d. medical facility, e recreational facility, f. kid's playground equipment, g. educational facility)<br>2.(a. public security, b. traffic safety, c. accident prevention measures, d. emergency shelter, e. disaster prevention publicity)<br>3.(a. park green land, b. greening, c. cleanliness, d. open space, e. density of buildings, f. neighborhood relationship, g. property management, h. construction landscape, i. community culture, j. urban identity)<br>4.(a. utilization of public services, b. smooth traffic, c. convenient commuting degree, d. convenient | presents an empirical analysis of the residential problems in Dalian, compares both evaluation and spatial differences across social groups |

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|---|---|---|---|---|---|---|---|
| | | | | | | mobility degree, e. convenient degree of going to downtown)<br>5.(a. automobile exhaust, b. industrial dust, c. water pollution, d. noise pollution, e. secondary pollution caused by waster tip) | |
| ] | Null | cartographic data,<br>Digital Elevation Model (DEM) | 5 indexes | 1.natural environment<br><br>2.cultural environment<br><br>3.domestic installation<br><br>4.public transport facility<br><br>5.safety facility | 18 indicators | 1.(a. terrain flatness, b. air quality, c. distance to pollution enterprise, d. noise pollution, e. landscape planting)<br>2.(a. higher education institution, b. attractions, c. urban identity)<br>3.(a. distance to school, b. distance to hospital, c. distance to supermarket, d. recreational and sports facility)<br>4.(a. distance to bus stop, b. distance to subway station)<br>5.(a. distance to police box, b. emergency shelter, c. distance to railway station and airport) | presents a method of urban dwelling feasibility evaluation based on GIS (Geographic Information System) |

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| ] | Dalian, China | survey data | 6 indexes | 1.convenience<br><br>2.safety<br><br>3.natural environment comfort level<br><br>4.cultural environment comfort level<br><br>5.facility of going out to travel<br><br>6.health | 33 indicators | 1.(a. retail, b. shopping facility, c. dining facility, d. medical facility, e. recreational facility, f. kid’s playground equipment, g. educational facility)<br>2.(a. public security, b. traffic safety, c. accident prevention measures, d. emergency shelter, e. disaster prevention publicity)<br>3.(a. park green land, b. landscaping of residential area, c. cleanness of residential area, d. open space, e. density of buildings)<br>4.(a. neighborhood relationship, b. property management, c. construction landscape, d. community culture, e. urban identity)<br>5.(a. utilization of public services, b. smooth traffic, c. convenient commuting degree, d. convenient | evaluates the spatial characteristics of urban residential suitability in Dalian taking administrative divisions and functional regions as basic unit |

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| | | | | | | mobility degree, e. convenient degree of going to downtown) 6.(a. automobile exhaust, b. industrial dust, c. water pollution, d. noise pollution from social activities, e. noise pollution from industries and roads, f. secondary pollution caused by waster tip) | |
| ] | Shandong Peninsula, China | hard data (2006) | 5 indexes | 1.urban residential condition<br><br>2.ecological surrounding<br><br>3.economical development<br><br>4.socio-cultural progress<br><br>5.urban infrastructure | 29 indicators | 1.(a. living space per capita, b. population density, c. investment in property as percentage of GDP, d. housing price increase rate)<br>2.(a. greening coverage rate in build-up area, b. green space per capita, c. domestic waste water treatment rate, d. up-to-standard discharge rate of industrial wastewater, e. domestic garbage harmless treatment rate) | Evaluate the livability of 8 cities of Shandong Peninsula |

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| | | | | | | 3.(a. GDP per capita, b. tertiary industry as percentage of GDP, c. unemployment rate, d. disposable income per capita, e. average wage of employee)<br>4.(a. number of theaters, b. number of books, c. student enrolment in higher education, d. social security as percentage of financial expenditure, e. number of beds in hospital, f. number of doctors)<br>5.(a. public transportation, b. area of paved road per capita, c. number of post office, d. road density, e. gas coverage rate, f. water coverage rate, g. number of taxis, h. number of phones per 100 population) | |
| ] | Chongqing, China | remote sensing data and survey | 7 index | 1. Climatic conditions<br>2. Economic Income | 78 indicator | 1.(a. temperature, b. humidity, c. sunshine hour, d. special weather, e. precipitation) | investigates the representative characteristic of the environmental habitat and features of urban development in Chongqing. |

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| | | | 3. Human Environment<br><br>4. Natural Environment<br><br>5. Basis Facilities<br><br>6. Traffic Situation<br><br>7. Public security | | 2.(a. Income per capita income, b. the growth rate of per capita)<br><br>3.( the distribution of nature reserves, scenic spots, parks, tourist destinations, cultural heritage, community environment,...)<br><br>4.(a. green space, b. water and wetland, c. atmosphereic environment, d. living environment)<br><br>5.( a. distribution of educational and cultural facilities, b. Medical and health facilities, c. commercial facilities, d. sports facilities, e. recreational facilities,...)<br><br>6.(a. distribution of all the road, b. distribution and the length of bus lines,...)<br><br>7.(a. Emergency Evacuation sites distribution, b. | |

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| | | | | | | distribution of fire and public security, c. Backwater flooded areas,...) | |
| ] | 33 Chinese cities | hard data (2004, 2005, 2006) | 5 grade indexes and 7 grade indexes | 1.security (a. urban safety)<br><br>2.comfort (a. environmental conditions, b. health care and leisure)<br><br>3.happiness (a. living quality)<br><br>4.convenience (a. infrastructure)<br><br>5.development (a. science, education and other social undertakings, b. economic development) | 23 indicators | 1.(a. public security, b. disaster prevention, c. transportation safety)<br>2.(a. pollution abatement, b. landscape planting, c. climatic conditions)<br>3.(a. medical condition, b. leisure and entertainment)<br>4.(a. employment, b. income level, c. housing conditions, d. welfare and remuneration, e. commercial service)<br>5.(a. public transportation, b. water supply, c. energy consumption, d. communication)<br>6.(a. education, b. scientific and technological level, c. social culture, d. urban management)<br>7.(a. economic level, b. economic structure) | Compare results with real livability conditions |
| | 5 cities in | hard data | 8 indexes | 1.air quality | 51 | 1.(a. sulfur dioxide | Validate the rationality of the |

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| ] | northwest China | | | 2.water quality<br>3.urban environment<br>4.infrastructure<br>5.healthcare and sanitation<br>6.education and social culture<br>7.economic performance<br>8.social insurance | indicators | concentration, b. nitrogen dioxide concentration, c. TSP, d. air pollution index)<br>2.(a. COD, b. DO, c. coliform counts, d. total phosphorus)<br>3.(a. rate of standardization areas of city environment noise, b. noise pollution, c. green area per capita, d. green coverage rate of built district, d. population density, e. up-to-standard discharge rate of industrial wastewater, f. utilization rate of industrial solid waste, g. up-to-standard discharge rate of industrial waste, h. sewage treatment rate)<br>4.(a. number of public transportation vehicles per 10,000 population, b. area of paved road per capita, c. average speed on arterial road, d, living space per capita, e. | objective appraisal index system and the standards |

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| | | | | | domestic water per capita, f. power consumption per capita, g. gas coverage rate, h. number of commercial facilities per 10000 population)<br>5.(a. number of beds in hospital per 10000 population, b. number of doctors per 10000 population, c. mortality, d. life expectancy)<br>6.(a. number of teachers per 10000 population, b. number of books per 1000 population, c. scientists and engineers in the percentage of employee, d. number of well-educated people, e. educational expenditures per capita, f. education as percentage of financial expenditure, g. number of theaters per million population, h. number of | |

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| | | | | | | attractions per 10000 population)<br>7.(a. average wage of employee, b. savings at year-end per capita, c. disposable income per capita, d. nonproductive expenditure per capita, e. expenditure in transportation and communications per capita, f. Engel's coefficient, g. energy consumption per 10000 Yuan of GDP, h. water consumption per 10000 Yuan of GDP)<br>8.(a. demographic burden per employed person, b. unemployment rate, c. percentage of population covered by social security, d. Gini coefficient, e. number of criminal cases per 10000 population) | |
| ] | 13 cities in Gansu Province, China | statistical yearbook (2007) | 4 indexes | 1.economy<br>2.urban environment | 22 factors | 1.(a. GDP per capita, b. disposable income per urban resident, c. fiscal revenue, d. | reflect that the city livability has the obvious relativity and regional characters. |

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| | | | | 3.resources carrying capacity<br><br>4.convinence | | retail sales, e. fixed-asset investment)<br>2.(a. air quality, b. quality of drinking water, c. greening coverage rate, d. green park area per capita, e. number of tourism attractions, f. cultural heritage, or urban characteristics)<br>3.(a. ecological elasticity, b. ecological carrying capacity, c. area of urban land-use)<br>4.(a. number of public transportation vehicles per 10000 population, b. investment on real estate development, c. the vacancy rate in commercial housing, d. number of middle schools, e. area of paved road per capita, f. gas coverage rate, g. number of hospital beds) | |
| ] | Tianjin | statistical yearbook and Environmental Protection | 5 index | 1.economy<br><br>2.education and culture | 25 indicator | 1.( GDP per capita, Financial income per capita, Per Capita Annual Disposable | determine the level of livability and ecology of Tianjin |

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| | Administration data 2007 | | 3.public project<br>4.environment<br>5.health and public safety | | Income of urban reside, Employment rate)<br>2.( number of Museum, library, cultural, umber of University Students, Enrollment rate of higher education, The rate of sub district with free)<br>3.( Percentage of Population with Access To Gas, Percentage of Population with Heat supply, Popularity Rate, Per Capita Area of Paved Roads, Parking Rate, per capita living space)<br>4.( Coverage Rate of Afforestation, Days of Air Quality Equal to or Above Grade II, Urban Drinking Water Sources quality rate, Percentage of sewage disposed, Innocuous Disposal Rate of Garbage, Percentage of Comprehensive Utilization of | |

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| | | | | | | Industrial Waste residue, Urban Area Average Noise Level)<br><br>5.( average life span, sickbeds per 10 000 people, crime detection rate, The full rate of urban lifeline) | |
| ] | Lanzhou, China | survey data (2007) | 5 grade indexes and 9 grade indexes | 1.security (a. urban safety, b. disaster prevention, c. transportation safety)<br><br>2.comfort (a. environmental conditions, b. health care and leisure)<br><br>3.happiness (a. living quality)<br><br>4.convenience (a. infrastructure)<br><br>5.development (a. science, education and other social undertakings, b. economic development) | 23 indicators | 1.(a. public security, b. disaster prevention, c. frequency of disasters, d. infrastructure security, e. transportation safety)<br>2.(a. pollution abatement, b. landscape planting, c. climatic conditions, d. medical condition, e. leisure and entertainment)<br>3.(a. employment, b. income level, c. housing conditions, d. welfare and remuneration, e. commercial service)<br>4.(a. public transportation, b. water supply, c. | Compare results with real livability conditions |

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| | | | | | | energy consumption, d. communication) 5.(a. education, b. scientific and technological level, c. social culture, d. natural heritage protection, e. citizen's awareness, f. urban identity, g. government efficiency, h. free from corruption, i. economic prosperity) | |
| ] | Shihezi City, Xinjiang, China | remote sensing data (2005), documentations | 3 indexes | 1.comfort<br>2.convenient<br>3.health | | a.1500 m buffer of schools, b. 2000 m buffer of supermarkets, c. 100 m buffer of main roads, d. 1500 m and 1000 m buffers of parks, e. 1000 m buffer of factories | evaluate the livability of urban residence and the most suitable sites |
| ] | Yixing City, Jiangsu, China | hard data (2006-2008) | 5 subsystems | 1.socio-economy development<br>2.life quality<br>3.environmental governance | 66 indicators | 1.(a. gross regional production (GRP) per capita, b. annual fiscal revenue per capita, c. urban unemployment rate, d. tertiary industry as percentage of GDO, e. | propose a new index system consisting of 3 layers; appraise Yixing in building a livable eco-city and the gap with a perfect condition. |

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| | | | 4.resources conservation<br><br>5.infrastructure | | Engel’s coefficient, f. Gini coefficient, g. urbanization level, h. student enrolment in higher education, i. sex ratio, j. number of criminal cases per 1000 population, k. satisfaction with public security)<br>2.(a. urban disposable income, b. per capita income of farmers, c. area of dwelling structure per capita, d. living space of urban minimal assurance households, e. low-rent housing ratio, f. average life span, g. area of road per capita, h. rural highway ratio, i. gas coverage rate, j. water coverage rate, k. tv network coverage rate, l. internet coverage rate, m. growing rate of price index, n. commercial facilities area per capita, o. local health services coverage rate, p. | |

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| | | | | | percentage of population covered by social insurance, q. number of art museums, libraries and cultural centers per 10000 population, r. parking spot rate, s. number of doctors per 10000 populations, t. number of legal workers per 10000 population) 3.(a. energy consumption per unit of GDP, b. water consumption per unit of GDP, c. green production ratio, d. ISO 14000 certified ratio, e. species diversity index, f. diversity index of local plants, g. area of nature reserve as percentage of the region, h. degraded land remediation rate, i. fresh water resource per capita) 4.(a. air quality, b. water qualification rate aquatic environment, c. | |

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| | | | | | discharge with standards, d. domestic garbage harmless treatment rate, e. rural fecal harmless treatment rate, f. utilization rate of industrial solid waste, g. water qualification rate of drinking water, h. reuse water rate, i. noise pollution, j. environment quality of attractions, k. publicity and education of environmental protection, l. green coverage rate of built district, m. green space per capita) 5.(a. urban lifeline systems, b. rate of gasification, c, annual pass percent of the water quality, d. average speed on main road, e. percentage of energy conservation designed buildings, f. number of public transportation vehicles per 10000 | |

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| | | | | | | population, g. share of public transit mode) | |
| ] | North-central cities in Jiangxi Province, China | Meteorological data in nearly 50 years and environmental data | 4 indexes | 1.disastrous weather<br><br>2.air quality<br><br>3.heat island (HI) index<br><br>4.comfort level | 17 factors | 1.(a. days with rainstorm, b. days with lightning disaster, c. days with strong winds, d. days with hail, e. days with heavy fog, f. days with snow disaster)<br>2.(a. concentration of sulfur dioxide, b. concentration of nitrogen dioxide, c. concentration of PM10)<br>3.(a. HI index at 02:00, b. HI index at 08:00, c. HI index at 14:00, d. HI index at 20:00)<br>4.(a. comfortable days at 02:00, b. comfortable days at 08:00, c. comfortable days at 14:00, d. comfortable days at 20:00) | analyze and evaluate the livability of north-central cities in Jiangxi Province via the perspective of climate and environment. |
| [25] | main cities of Chongqing, China | statistical yearbook (2009), survey data | 5 indexes | 1. urban economy<br><br>2. urban environment<br><br>3. urban living conditions | 27 factors | 1.(a. GDP per capita, b. disposable income per capita, c. retail sales of consumer goods per capita, d. reserve balance at year-end, e. average | to identify their own development and construction of a suitable direction |

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| | | | 4. urban security conditions<br><br>5. convenience of living | | wage of employees, f. registered unemployment rate)<br>2.(a. green coverage rate in built up area, b. greening space per capita, c. domestic garbage harmless treatment rate, d. days with good air quality, e. utilization rate of three industrial wastes, f. satisfaction with urban environment)<br>3.(a. living space per capita, b. investment in real estate development, c. completed investment in real estate development)<br>4.(a. number of beds in hospital per 10000 population, b. endowment insurance coverage rate, c. basic health insurance coverage rate, d. number of beds in social welfare institutions per 10000 population, e. population covered by | |

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| | | | | | | subsistence allowances) 5.(a. highway passenger capacity, b. TV coverage rate, c. water supply coverage rate, d. gas coverage rate, e. number of library books per 10000 population, f. number of primary and middle school teachers, g. number of facilities for the convenience of urban residents) | |
| ] | Zhongyuan urban agglomeration, China | hard data and statistical yearbook (2007) | 5 indexes | 1.living conditions<br>2.ecological environment<br>3.social economy<br>4.social culture<br>5.infrastructures | 26 factors | 1.(a. living space per capita, b. area of road per capita, c. population density, d. housing price-to-income ratio, e. investment in real estate development as percentage of GDP) 2.(a. greening coverage rate in built up area, b. green space per capita, c. sewage treatment rate, d. wastes harmless treatment rate, e. days with good air quality) | comparative study of the region and beyond |

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| | | | | | | 3.(a. GDP per capita, b. tertiary industry as percentage of GDP, c. registered unemployment rate in urban, d. endowment insurance coverage rate, e. Engel coefficient)<br>4.(a. number of books per 100 peoples, b. student enrolment in higher education, c. fiscal expenditure on social insurance, d. number of hospital beds, e. number of doctors)<br>5.(a. internet penetration rate, b. road network density, c. gas coverage rate, d. water supply coverage rate, e. number of taxies per 10000 peoples, f. number of phones per 100 peoples) | |
| ] | Beijing City, and 3 global cities (New York City, Greater London, and Tokyo) | hard data (2000-2009) | 3 criteria layers and 8 factor layers | 1.Social progress (a. Economic development, b. Social security) | 21 indicators | 1.(a. Per capita GDP, b. Proportion of tertiary industry in GDP, c. Registered unemployment rate in urban, d. Deaths per | Compare Beijing with three global cities (New York City, Greater London, and Tokyo), clarifying whether Beijing has great potential to grow into a global city. |

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| | | | | 2.Living level (a. Health condition, b. Quality of life, c. Basic services)<br><br>3.Environmental quality (a. Water quality, b. Air quality, c. Resource and usage) | | 10000 vehicles from motor vehicle accidents)<br>2.(a. Infant mortality, b. Life expectancy, c. Per capita disposable income, d. Per capita usable space of houses in urban areas, e. Time taken to travel to work, f. Engel's coefficient of urban households, g. New enrollments per 1000 population in colleges & universities, h. Certified physicians per 10000 population, i. Number of libraries)<br>3.(a. COD discharge volume per 10000 USD of GDP, b. Rate of waste water disposed, c. Daily mean of sulfur dioxide, d. Daily mean of nitrogen oxides, e. Annual mean of PM10, f. Consumed water per 10000 USD of GDP, g. Per capita park green area) | |
| , | Australian cities, Melbourne) 2010 | Survey data 2010 | 5 index | 1. stability | 30 indicator | 1.( prevalence of petty crime and violent | explores the prospects for a socio-technical transition of key |

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| ] | | | | 2. healthcare<br><br>3. culture and environment<br><br>4. education<br><br>5. infrastructure | | crime, threat of military conflict, threat of civil unrest/conflict, threat of terrorism)<br><br>2.( availability of public and private healthcare, quality of public and private healthcare, availability of over-the-counter pharmaceuticals, general healthcare indicators)<br><br>3.( humidity/temperature rating, discomfort of climate to travelers, level of corruption, social/religious restrictions, level of censorship, recreation, sport, culture, food and drink, availability of consumer goods and services)<br><br>4.( availability of private education, quality of private education provision, | urban infrastructure systems—energy, water, waste, transport, communications and buildings—as a basis for winding back unsustainable levels of consumption while maintaining liveability. |

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| | | | | | | public education indicators)<br><br>5.( quality of road network, public transport and international links, quality of housing, quality of energy and water provision, quality of telecommunications infrastructure) | |
| ] | Null | Null | 6 indexes | 1.the conditions of urban living and resources,<br><br>2.the urban economic development,<br><br>3.the urban conditions of society, politics, science, education, culture and medical,<br><br>4.the urban infrastructure,<br><br>5.the urban public security | 69 indicators | 1.(a. living space per capita, b. housing price, c. population density, d. investment in property as percentage of GDP, e. guarantee capacity of resources, f. energy consumption per capita, g. food safety, h. reuse rate of industrial wastewater, i. fresh water per capita, j. abundance of tourism resources)<br>2.(a. employment rate, b. average wage of employee, c. disposable income per capita, d. fiscal revenue per capita, e. | Point out the "bottleneck" is the main reason affecting livability; bring forward the priority of constructing livable cities in China |

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| | | | 6.the urban environment | | Engel’s coefficient, f. Gini coefficient, g. tertiary industry as percentage of GDP, h. secondary industry as percentage of GDP, i. average value of retail sales, j. gross regional production as percentage of GDP, k. enterprise innovation ability)<br>3.(a. number of kindergartens per 1000 population, b. number of primary schools per 1000 population, c. number of secondary schools per 1000 population, d. higher education entrance rate, e. technical secondary school or above per 10000 population, f. number of doctors per 10000 population, g. life expectancy, h. natural population growth rate, i. number of books per 10000 population, j. number of theaters per 10000 population, k. | |

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| | | | | | government decision making, l. transparency of government, m. democratic supervision, n. community services) 4.(a. number of public transportation vehicles per 10000 population, b. number of taxies per 10000 population, c. road density, d. road length per capita, d. water and energy supply, e. gas coverage rate, f. number of hospitals per square km, g. number of supermarkets per square km, h. number of banks and communication facilities per square km, i. urban drainage facility, j. rates of phone penetration) 5.(a. police strength, b. criminal cases per 10000 population, c. percentage of population covered by social security, f. care | |

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| | | | | | | for vulnerable groups, g. social assistance, h. floating population employment, i. natural disasters preventions, j. man-made disaster preventions, k. property management) 6.(a. greening coverage rate in built up area, b. green space per capita, c. proportion of days with good air quality, d. noise pollution, e. up-to-standard discharge rate of industrial wastewater, f. domestic wastewater treatment rate, g. surface water quality, h. domestic garbage harmless treatment rate, i. number of sanitation workers per 10000 population, j. number of parks per 10000 population, k. city appearance, l. historical site protection) | |
| 2[54] | Changchun City, | topographic | 5 factors | 1.Ecological | 28 | 1.(a. roughness, b. | Evaluation of Environmental |

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| China | maps (2006), digital elevation model (DEM), and meteorological data (1955-2005) | | environment<br><br>2.Convenience<br><br>3.Amenity<br><br>4.Health<br><br>5.Safety | indicators | temperature-humidity index, c. wind effect index, d. hydrology index)<br>2.(a. convenience of bus station, b. convenience of bus line, c. density of bus station, d. density of bus line, e. convenience of city center, f. convenience of light way sites, g. convenience of railway station and passenger station, h. convenience of shops and supermarkets, i. convenience of restaurants and hotels, j. convenience of health facilities, k. convenience of recreation facilities, l. convenience of primary and middle schools)<br>3.(a. vegetation coverage, b. adjacent degree to water area, c. adjacent degree to parks and squares, d. adjacent degree to cultural facilities) | Livability of Changchun Based on GIS and RS |

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| | | | | | | 4.(a. road density, b. degree far from industrial pollution, c. degree far from traffic noise, d. degree far from life noise)<br>5.(a. population density, b. density of main road, c. degree far from chemical pollution) | |
| ] | Tianjin City, China | hard data (2005-2009) | 13 indexes | 1.economic performance (a. economic capacity, b. economic structure, c. economic benefit)<br><br>2.culture and education (a. educational structure, b. education quality)<br><br>3.infrastructure (a. domestic installation, b. public facilities)<br><br>4.ecological environment (a. greening, b. pollution abatement, c. | 37 indicators | 1.(a. GDP per capita, b. fiscal revenue per capita, c. rural resident's income per capita, d. Engel's coefficient, e. tertiary industry as percentage of GDP, f. living space per capita, g. social labor productivity, h. energy consumption per unit GDP, i. water consumption per unit GDP)<br>2.(a. number of libraries per million population, b. number of college students per 10000 population, c. rate of schooling for school-age children, d. educational | Build Tianjin ecological livable city index system |

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| | | | environmental quality)<br><br>5.social security (a. health services, b. social welfare, c. public security) | | investment as percentage of GDP)<br>3.(a. gas coverage rate, b. central heating coverage rate, c. water coverage rate, d. TV household coverage rate, e. PC penetration rates, f. road length per capita)<br>4.(a. greening coverage rate, b. green space per capita, c. domestic wastewater harmless treatment rate, d. domestic garbage harmless treatment rate, e. utilization rate of industrial solid waste, f. noise pollution, g. days with air quality equal to or above Grade II, h. drinking water quality, i. offshore water quality)<br>5.(a. average life span, b. number of beds in hospital per 1000 population, c. percentage of population covered by | |

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| | | | | | | social insurance, d. unemployment rate, e. rate of solved criminal cases, f. urban lifeline system) | |
| ıg ] | Taichung City, Taiwan | Air Monitorin g data and administration publications from 2010 | 1 index | Environmental index | 15 indicators | Weather, air pollution, and environment aspects and each respective factor. | Suggests an evaluation approach that includes factors such as weather, air pollution, and environmental aspects to quantify the livable urban environment in a city. |
| ı, ] | European city | Survey and data (2204,2006,2009) | 10 index | 1. political and social environment<br>2. economic environment<br>3. socio-cultural environment<br>4. health and sanitation<br>5. schools and education<br>6. public services and transportation<br>7. recreation<br>8. consumer goods<br>9. housing<br>10. natural environment | 39 indicator | 1.( political stability, crime, law enforcement, etc)<br>2.( currency exchange regulations, banking services, etc)<br>3.( censorship, limitations on personal freedom, etc)<br>4.( medical supplies and services, infectious diseases, sewage, waste disposal, air pollution, etc)<br>5.( standard and availability of international schools, etc)<br>6.( electricity, water, public transport, | To investigate the relationship between the popular Mercer city ranking (livability) and survey data (satisfactions) |

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| | | | | | | traffic congestion, etc)<br><br>7.( restaurants, theaters, cinemas, sports and leisure, etc)<br><br>8.( availability of food/daily consumption items, cars, etc)<br><br>9.( housing, household appliances, furniture, maintenance services, etc)<br><br>10.( climate, record of natural disasters) | |
| .<br><br>] | Taiwan | public facilities, software, hardware 2007 | 7<br><br>indexes | 1. Overall Development<br><br>2. Advanced Infrastructure<br><br>3. Health Care<br><br>4. Housing Standards<br><br>5. Purchasing Capacity<br><br>6. Job Availability<br><br>7. Health | 32<br><br>indicators | 1.(a. Educational Level, b. Electricity Consumption, c. Indoor Telephones, d. Non-farming Population, e. Urban Area, f. Home Computers, g. Population)<br><br>2.(a. Household Income, b. Disposable Income, c. Family Expenditures, d. Sewage Disposal, e. Housing Expenditures, f. Traffic Accidents) | To determine the main factors that have a bearing on livability in Taiwan |

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| | | | | | | 3.(a. Crime Rate, b. Print Media, c. Heaters and Air Conditioners, d. No. of TVs)<br><br>4.(a. Western Doctors. B. Correspondence Rate)<br><br>5.(a. Home Ownership, b. Indoor Plumbing, c. Housing Construction)<br><br>6.(a. No. of Households, per capita expenditure)<br><br>7.(a. Road Density, b. Employment Rate)<br><br>8.(a. Food Expenditures, b. Garbage Collection) | |
| ohi,<br><br>] | Tehran(Darake) | survey | 3 index | 1. Resilience<br><br>2. Inclusiveness<br><br>3. Authenticity | 16<br><br>indicator | 1.( transportation, economy, governance, substructures, pollutions and clean energy, Land use and urban services,...)<br><br>2.(poverty, security and safety, health, Public spaces,...)<br><br>3.( Cultural heritage, Sense of place, Vision and urban landscape, | measuring and evaluating the viability of Tehran |

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| | | | | | | Technology, innovation and linkages,...) | |
| ] | India (Bhopal) | Survey | 8 index | 1. infrastructure and public services<br>2. recreation and amenities<br>3. community spaces<br>4. good connectivity<br>5. cleanliness and natural environment<br>6. distinct characteristics<br>7. recreation and amenities<br>8.housing option | Null | Null | describes the process that was used to define successful livability performance and match the professional's definition against the inhabitant's definitions of livability performance |
| ıga,<br>n L<br>] | Aizawl, India | Data base and survey 2011 | 6 index | 1. Economic<br>2. Social<br>3. Household<br>4. Accessibility<br>5. Satisfaction from socio-economic environment<br>6. Satisfaction from physical and | 51 indicator | 1. (income, tertiary, bank, insurance, computer, internet,...)<br>2. (average household size, sex ratio, schools/1,000 population, health centers/1,000 population, recreation,...) | Identify dimensions and indicators of subjective and objective livabilities and overall index of urban livability for Aizawl city. |

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| | | | | infrastructural environment | | 3.( Average rent per household, Average room per household, Percentage of owned households to total households,...)<br><br>4.( Average distance to church, Average distance to playground, main road, nearest bank, nearest health center)<br><br>5.( Satisfaction of job opportunities in neighborhood, upbringing of children, incidence of crime, cost of living, intimacy, garage and water,...)<br><br>6.( Satisfaction from slope of house site, length of receiving sunlight, system of LPG, condition of road, availability of public transport, safety from natural hazards,...) | |
| ee<br><br>] | 64 global cities | Yearbook and Database | 5 index | 1. Economic Vibrancy and Competitiveness | 85 indicator | 1.(a. Economic performance, b. Economic openness, c. Infrastructure) | use of a new measure of liveability – the GLCI – to rank the 64 world's major cities and conducts policy simulations to |

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| | | | | 2. Environmental Friendliness and Sustainability<br><br>3. Domestic Security and Stability 4. SocioCultural Conditions<br><br>5. Political Governance | | 2. (a. Pollution, b. Depletion of natural resources, c. Environmental initiatives)<br><br>3. (a. Crime rate, b. Threat to national security, c. Civil unrest)<br><br>4. (a. Medical and health care, b. Education,<br><br>c. Housing sanitation and transportation, d. Income inequality and demographic burden,<br><br>e. Diversity and community cohesion)<br><br>5.(a. Policy making and implementation b. Government system, c. Transparency and accountability, d. Corruption) | help aid city planners invest in areas with low scores in the GLCI. |
| ɔur,<br>ɹd<br><br>] | Districts 22 and 10 of Tehran | library and survey methods | 9<br><br>indexes | 1 .Economic<br><br>2. social – cultural<br><br>3. environmental | 9<br><br>indicators | 1. (a. Public transport, b. Structural welfare and services, c. The ability riding bike and pedestrian)<br><br>2.(a. Public and private health care assess, b. Social and | evaluate the livability of District 22 and 10 of Tehran |

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| | | | | | | personal security, c. Sense of space, d. General education)<br><br>3.(a. Access to green space and parks, b. Air pollution and wastewater situation Source) | |
| , M.<br><br>] | Barcelona(Spain) | Real time data | 11 index | 1. Protection of green space<br><br>2.quality of public space<br><br>3.improve mobility<br><br>4.optimal level of environmental quality<br><br>5.conserve nature resource<br><br>6.reduce waste production<br><br>7.increase social cohesion<br><br>8.foster economic activity<br><br>9.progress of sustainability<br><br>10.reduce city impact on the planet | 26 indicator | 1.(bird biodiversity, green area per inhabitant)<br><br>2. ( index of urban renovation, availability to public space)<br><br>3.(modes of transport population, protection of street with priority to pedestrian)<br><br>4.(level of noise pollution, environmental quality of beaches, quality of air, life expectancy)<br><br>5.(water consumption, public consumption groundwater, energy consumption)<br><br>6.(collection of organic material, selective waste | the construction of synthetic indices using principal component analysis (PCA) of liveability in Barcelona |

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| | | | | 11.indicator related to all objective of sustainability | | collection, generation of urban solid waste)<br><br>7.(academic failure, accessibility to house, population finishing university studies, degree of association)<br><br>8.(number of organization with environmental certificates)<br><br>9.(schools with participation in environmental education)<br><br>10.(CO2 emission, number of points of sale or consumption of product)<br><br>11.(degree of citizen satisfaction) | |
| an-<br>S.<br>] | Iran and Estonia | experts' opinions data<br><br>2012-2013 | 3 index | 1. built-form<br><br>2.spatial quality<br><br>3.social/community factors | 32 indicator | 1. (a. An alternative appearance to the facades, b. The proportion and scale of the spaces enclosed by buildings, c. The provision of mixed-use buildings, d. Number of stores)<br><br>2.(a. amount of green space, b. Presence of | identify key criteria for building liveable urban neighborhoods in two very different countries |

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| | | | | | | trees and natural elements, c. Presence of water features, d. Management of the spaces, e. The sense of hierarchy between public and private spaces, f. Quality of access to the residential public spaces, g. Easy way-finding in the neighborhood spaces, h. Visibility of public spaces)<br><br>3.(a. Usability of routes, b. Quality of pavements and footpath surfaces, c. Volume and speed of vehicles, d. Separation of pedestrian and road traffic, e. Lighting during the night-time, f. Territorial functioning, g. Presence of a variety of people in neighborhood public spaces) | |
| :.<br><br>] | Perth, Australia | EIU’s liveability survey 2013 | 5 indexes | 1. stability<br><br>2. healthcare availability of | 30<br><br>indicators | 1.( Prevalence of petty crime, violent crime, Threat of terror, military | To examine characteristics of liveable cities, and then provide a snapshot of Perth as a liveable city, |

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| | | | | private healthcare<br><br>3. culture and environment<br><br>4. education<br><br>5. infrastructure | | conflict and civil unrest/conflict)<br><br>2.( Quality of private healthcare, public healthcare, Availability of over-the-counter drugs and General healthcare indicators)<br><br>3.( Humidity/temperature rating, Level of censorship, corruption, Cultural availability and Food and drink and ...)<br><br>4.( Quality of private education, Public education indicators and ,...)<br><br>5.( Quality of road network, public transport, energy and water provision,..) | |
| ga,<br><br>] | Johor, Malaysia | survey | 11 index | 1. Urban Infrastructure and Services<br><br>2. Climate Resiliency and Disaster Preparedness | 76 indicator | 1.( affordable quality public housing, telecommunication with global network, safe and orderly sidewalks and overpasses and access to electricity,...) | To develop appropriate urban livability indicators for Metropolitan Johor |

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| | | | 3. Protection of Urban Environmental Resources<br><br>4. Public Health and Wellness Services<br><br>5. Choices and Access to Quality Education<br><br>6. Social Equality and Security<br><br>7. Urban Services, Recreation and Accommodation Facilities<br><br>8. Dynamism and Promotion of Local Economy<br><br>9. Ease in Urban Transportation and Mobility<br><br>10. Good Governance<br><br>11. Social Cohesion and Connectedness | | 2.( recreation, public parks, public markets, shopping malls,..)<br><br>3.( flood control system, availability of risk reduction facilities, disaster response system,...)<br><br>4.( drainage system, air quality, water quality,...)<br><br>5.( health/medical subsidy, ratio of hospital bed to 1000 population, response to medical emergencies,...)<br><br>6.( percent of college dropout, teacher-student ratio in elementary level, education centers for out-of school youth,...)<br><br>7.( crime rate incidence, ratio of police to population, crime prevention measures,...)<br><br>8.( sense of local community, sense of local community,...) | |

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| | | | | | | 9.( accountable city officials, responsive to needs of citizens,...)<br><br>10.( employment rate, average income, inflation rate,...)<br><br>11.( availability of road signs, availability of bicycle lanes, urban transport connectivity,...) | |
| 4.<br><br>] | Melbourne | literature review and consultation workshops and feedback sessions with decision-makers | 11 indexes | 1. Crime and safety<br><br>2. Transport<br><br>3. Housing<br><br>4. employment and income<br><br>5. Social cohesion and local democracy<br><br>6. Public open space<br><br>7. leisure and culture<br><br>8. Health and social services<br><br>9. Natural environment<br><br>10. Education | Null | 1. (a. Perceptions of safety, b. rates of crimes against property and the person)<br><br>2.(a. the accessibility, b. quality and layout of infrastructure, c.travel times and distances,...)<br><br>3.(a. Quality and affordability of housing)<br><br>4.(a. housing stock and tenure)<br><br>5.( Opportunities to contribute to important issues)<br><br>6.( Access to and quantity of public open | review existing liveability indicators and considers how they are utilized |

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| | | | | 11. Food and other local goods | | space)<br><br>7.( Access to and presence of appropriate cultural and leisure activities measured both objectively and subjectively)<br><br>8.( The distance to and number of General Practices for a given population)<br><br>9.(Water and air quality)<br><br>10.( Access to education)<br><br>11.( Access to different types of food and shops) | |
| ] | 100 Chinese cities | hard data (2010) and survey data (2014) | 5 indexes | 1.economic vibrancy and competitiveness<br><br>2.environmental friendliness and sustainability<br><br>3.domestic security and stability<br><br>4.socio-cultural conditions | 96 indicators | 1.(a. Economic performance, b. Economic openness, c. Infrastructure)<br>2. (a. Pollution, b. Depletion of natural resources, c. Environmental initiatives)<br>3. (a. Crime rate, b. Threat to national security, c. Civil unrest) | Rank the liveability of 100 cities in the Greater China Region |

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| | | | | 5. Political governance. | | 4. (a. Medical and health care, b. Education, c. Housing sanitation and transportation, d. Income inequality and demographic burden, e. Diversity and community cohesion) 5.(a. Policy making and implementation b. Government system, c. Transparency and accountability, d. Corruption) | |
| , N. ] | Malaysia | Interview and focus group | 5 index | 1. Preservation of Religion 2. Preservation of Life 3. Preservation of Intellect 4. Preservation of Lineage 5. Preservation of Poperty | 9 indicator | 1.( Social network) 2.( a. Economic, social and political stability, b. Healthcare - Culture & environmental , c. Education , d. Transportation) 3.( a. Education: schools and universities) 4.( Nil) 5.( a. Economic wellbeing, high salaries, economic stability) | This research engages in the combined methodology which involves Focus Group Discussions, Interviews and Perception surveys in the formulation of the liveable city planning methodology based on Islamic human wellbeing indicators via the Maqasid Al-Shari'ah(Malaysia)fundamentals. |
| lli, | central Italy | spatial indices, | 2 indexes | 1. Ecosystem | 43 | 1. (a. land use, b. land | developing a methodology for |

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| ] | | data collected from local authorities and open databases | | Services<br><br>2. Urban Services | indicators | cover data and....)<br><br>2. Variable on the map based on their place of living. | liveability spatial assessment based on ES and US mapping and stakeholders involvement to quantify their relative relevance. |
| ] | 10 megacities in China (Beijing, Tianjin, Shanghai, Guangzhou, Chongqing, Shenyang, Nanjing, Wuhan, Chengdu, and Xi'an) | time-series data (1978-2012) | 3 dimensions | 1.Society<br><br>2.Economy<br><br>3.Environment | 7 indicators | Genuine Progress Indicator (GPI),<br><br>Ecological Footprint (EF) and Biocapacity (BC),<br><br>Environmental Performance Index (EPI),<br><br>City Development Index (CDI),<br><br>Human Development Index (HDI),<br><br>Gini coefficient,<br><br>Urban-rural income ratio | Gauge the urban sustainability of China, focusing on 10 socioeconomic centers |
| ] | 18 cities in Henan, China | yearbook (2014), Environment Quality Communique (2013) | 4 indexes | 1.resource consumption<br><br>2.living environment<br><br>3. ecological maintenance | 19 factors | 1.(a. energy consumption per GDP, b. energy consumption per added value of industrial output, c. gas coverage rate in urban) | evaluate the ecological livable city construction in Henan Province, and give some suggestions. |

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| | | | | 4.pollution abatement | | 2.(a. days with good air quality, b. quality of groundwater and surface water, c. acoustic environment, d. area of park green space, e. housing space per capita, f. area of road per capita)<br>3.(a. added afforested area as percentage of land areas, b. greening rate in built up area, c. fixed investment in water conservancy, environment and public facility management, d. fiscal expenditure on energy conservation and agriculture, forestry, and water resource)<br>4.(a. utilization rate of industrial solid waste, b. sewage treatment rate, c. domestic garbage harmless treatment rate, d. wastewater discharge volume, e. nitrogen oxide emission, dust emission) | |
| [69] | Suzhou city, | survey data | 6 indexes | 1. human | 25 factors | 1.(a. living conditions, | To build the evaluation index |

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| | Jiangsu Province, China | (2016) | | settlement and economy<br><br>2. infrastructures<br><br>3. humanity and social science<br><br>4. social security<br><br>5. ecological environment<br><br>6.political governance | | b. housing price, c. income level, d. price level, e. wage growth)<br>2.(a. traffic network, b. living facilities, c. postal finance, d. business travel)<br>3.(a. educational institution, b. entertainment, c. educational environment, d. quality of citizens)<br>4.(a. social insurance, b. health care, c. neighborhood relationship, d. security)<br>5.(a. greening coverage rate, b. environment in urban area, c. resources conservation, d. air quality)<br>6.(a. policy making, b. service awareness, c. openness and transparency, d. public participation) | system of ecological livable city from the view of residents' satisfaction |
| ee<br><br>] | Abu Dhabi | Yearbook and Database | 5 index | 1. Economic Vibrancy and Competitiveness | 85 indicator | 1.(a. Economic performance, b. Economic openness, c. Infrastructure) | To use of a new measure of liveability – the GLCI – to rank the Abu Dhabi and conducts policy simulations to help aid city |

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| | | | | 2. Environmental Friendliness and Sustainability<br><br>3. Domestic Security and Stability<br><br>4. SocioCultural Conditions<br><br>5. Political Governance | | 2. (a. Pollution, b. Depletion of natural resources, c. Environmental initiatives)<br><br>3. (a. Crime rate, b. Threat to national security, c. Civil unrest)<br><br>4. (a. Medical and health care, b. Education,<br><br>c. Housing sanitation and transportation, d. Income inequality and demographic burden,<br><br>e. Diversity and community cohesion)<br><br>5.(a. Policy making and implementation b. Government system, c. Transparency and accountability, d. Corruption) | planners invest in areas with low scores in the GLCI in Abu Dhabi. |
| 7[5] | 35 large and medium-sized Chinese cities | spatial panel data (2003-2012) | 5 factors | 1.Abundance (Abundant material and cultural life)<br><br>2.Convenience (Convenient public services) | 18 indicators | 1.(a. added value of the service industry, b. number of library books, c. number of employees working in culture, sports and entertainment, d. expenditure of the | To address the interdependence of the emerging tourist industry and local livability in Chinese cities |

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| | | | 3.Comfort (Healthy and comfortable living environment)<br><br>4.Welfare (Good social welfare)<br><br>5.Safety (Security of production and living) | | local authority, e. retail sales of consumer goods)<br>2.(a. average length of roads per 1000 persons, b. average amount of domestic water supply per 1000 persons, c. average amount of electricity per 1000 persons, d. average number of doctors per 1000 persons, e. average number of universities and colleges per $km^2$)<br>3.(a. number of days when air quality is equal to or better than Level II, b. amount of sewage processed in 1000 $m^2$, c. amount of household garbage processed in 1000 tons)<br>4.(a. unemployment insurance cover per 1000 persons, b. pension insurance cover per 1000 persons)<br>5.(a. economic loss per traffic accident, b. | |

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| | | | | | | fatal traffic accident per 1000 persons) | |
| ] | Xianning,China | “Xianning City Statistical Yearbook(2010-2013)”and survey data | 4 indexes | 1. Economic prosperity<br><br>2. City environmental beauty<br><br>3. Regional resource carrying capacity Weight<br><br>4. Life convenience Weight | 21 indicators | 1.(a. Per capita GDP, b. Per capita disposable income of urban residents, c. Per capita fiscal revenue, d. Third industry accounted for GDP)<br><br>2.(a. City climate, b. city air quality, c. Natural landscape, d. Places of historic figures and cultural heritage)<br><br>3.(a. Proportion of urban population in the region, b. Per capita possession of fresh water resources, c. Specialty resources, d. The per capita gross output value)<br><br>4.(a. Per capita housing construction area, b. Per capita retail sales of social consumer goods, c. Per capita investment in fixed assets, d. City | analysis and evaluation of Xianning in the aspects of economy, resources, life and environmental suitable degree of livability |

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| | | | | | | transportation, e. Public Health) | |
| ] | Beijing, China | hard data (2000-2014) | 5 dimensions (14 element layers) | 1.city safety<br>2.life quality<br>3.natural environment<br>4.social harmony<br>5.open innovation | 35 indicators | 1.(a. safety index, b. qualified rate of food and medicine, c. average area of emergency shelter per capita)<br>2.(a. number of full-time teachers per primary school student, b. number of beds in hospital per 1000 persons, c. average life expectancy, d. number of nursing beds per 100 elders, e. sports and cultural facilities, f. average area of public service facilities per 100 community residents, g. average area of housing per urban resident, h. length of rail transit, i. rate of public transit, j. transportation index)<br>3.(a. annual average of PM2.5, b. surface water qualification rate c. sewage treatment rate, d. | To provide a better understanding on current construction of world-class metropolis of harmony and livability in Beijing |

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| | | | | | domestic garbage harmless treatment rate, e. average value of ambient noise, f. coverage rate of 500 m service radius of park green, g. forest coverage rate, h. environmental sanitation index) 4.(a. urban residents' high-low income ratio, b. registered unemployment rate in urban, c. criminal cases per 10000 population, d. civilization index of citizens, e. registered volunteers as percentage of local population, f. Beijing-Tianjin-Hebei Region's income gap, g. income gap between urban-rural residents) 5.(a. civil aviation passenger traffic, b. foreign population, c. number of headquarters of multinational corporations, d. number of | | |

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| | | | | | | international congress and exhibition, e. proportion of research and experimental development expenditure, f. number of patents per 10000 population, g. proportion of added value of technology industry, h. proportion of renewable energy and new energy) | |
| 7[29] | 37 cities in Northeast China | panel data (2007-2014) | 4 dimensions | 1.economic prosperity level<br><br>2.level of beautiful environment<br><br>3.public security level<br><br>4.life convenience level | 35 indicators | 1.(a. GDP per capita, b. disposable income per urban resident, c. net income per rural resident, d. retail sales of consumer goods per capita, e. tertiary industry as percentage of GDP, f. average wage of employee, g. fiscal expenditure on science and technology, h. educational funds expenditure per 10000 population)<br>2.(a. green space per capita, b. greening rate in urban area, c. annual average | To evaluate the livability level of 37 cities in northeast China from 2007 to 2014 and its spatio-temporal evolution characteristics |

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| | | | | | temperature, d. annual average precipitation, e. utilization rate of industrial solid waste, f. sewage treatment rate, g. domestic garbage harmless treatment rate, h. number of parks) 3.(a. pension insurance coverage rate, b. health insurance coverage rate, c. unemployment insurance coverage rate, d. number of criminal cases, e. registered unemployment, f. deaths from traffic accidents) 4.(a. number of public transportation vehicles per 10000 population, b. area of urban road per capita, c. number of taxies per 10000 population, d. length of drainage pipes, e. gas coverage rate, f. water supply coverage rate, g. index of communication, h. | |

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| | | | | | | number of hospitals and health centers, i. number of library books per 100 population, j. number of theaters, k. number of schools, l. living space per capita, m. employment proportion of wholesale and retail, accommodation and catering, and residential service) | |
| ] | Wuhan City, China | statistical data (2014), POI data (2014), remote sensing images (2016) | 4 indexes | 1.economic prosperity level<br><br>2.level of beautiful environment<br><br>3.resource load level<br><br>4.life convenience level | 18 indicators | 1.(a. GDP per capita, b. disposable income per urban resident, c. employment rate, d. tertiary industry as percentage of GDP)<br>2.(a. number of days with air quality equal to or above Grade II, b. green space per capita, c. greening coverage rate, d. wetland area per capita)<br>3.(a. available fresh water resource per capita, b. urban land area per capita)<br>4.(a. road area per capita, b. number of | Conduct the livability evaluation from the perspective of city, administrative district, neighborhood and street scale, to provide reference for the improvement of livability of Wuhan |

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| | | | | | | bus stops within street service radium, c. number of primary schools within street service radium, d. number of middle schools within street service radium, e. building density (proportion of building area), f. floor area ratio (FAR), g. housing area per capita, h. number of hospitals within street service radium, i. number of community health service institutions) | |
| ] | Shanghai City, China | statistical yearbook (1967-2012) | 5 indexes | 1.stability<br>2.medical care<br>3.education<br>4.environment<br>5.infrastructure | 10 indicators | 1.(a. number of criminal cases per 0.1 million population, b. number of traffic accidents per 10000 population)<br>2.(a. number of beds in hospital per 10000 population)<br>3.(a. number of primary and secondary schools per 0.1 million population)<br>4.(a. area of parks per capita, b. Sulphur | 1.Propose and verify the “N-curve hypothesis” of livability in global cities by comparing of New York, Tokyo and Shanghai.<br>2.Predict the development of livability in Shanghai in next 30 years by setting 4 scenarios. |

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| | | | | | | dioxide concentration, c. carbon emission) 5.(a. internet subscriber coverage rate, b. road density, c. living space per capita) | |
| ] | 8 Chinese cities (Suqian, Lianyungang, Suzhou, Shangqiu, Jining, Zaozhuang, Xuzhou, Huaibei) | statistical data (2016) | 6 indexes | 1.social civilization level<br><br>2.economic prosperity level<br><br>3.level of beautiful environment<br><br>4.resource load level<br><br>5.life convenience level<br><br>6.public security level | 20 indicators | 1.(a. social insurance coverage rate, b. rate of solved criminal cases, c. employment rate of floating population) 2.(a. gross regional production per capita, b. proportion of tertiary industry, c. annual GDP growth rate, d. labor productivity, e. educational expenditure as percentage of GDP) 3.(a. green space per capita, b. number of days with air quality equal to or above Grade II, c. domestic garbage harmless treatment rate, d. three industrial wastes harmless treatment rate, e. | Evaluate livability of each city, and classify them into three types of livable city and do Friedman test. |

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| | | | | | | proportion of region up to noise standard) 4.(a. fresh water per capita) 5.(a. number of public transportation vehicles per capita, c. urban coverage rate, d. living space per capita in urban) 6.(a. number of doctors per 10000 population, b. morbidity of category A and B infectious diseases, c. completeness of lifeline system) | |
| | New York, Tokyo, and Shanghai | Census Center and Statistical Yearbook1967-2012 | 5 indexes | 1. Safety 2. Health 3.convenience 4.amenity 5.environment | 10 indicators | 1.(a. crime rate, b. traffic accident rate) 2.(a. availability of medical institution) 3.(a. internet availability, b. road density) 4.(a. school availability, b. living space) 5.(a. availability of space parks, b.SO2 concentration, c. CO2 emission) | comparison of livability across the three cities |
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| , ] | Skopje(Macedonia) | survey | 6 index | 1.physiological well-being<br>2.autonomy<br>3.personal growth<br>4.self-acceptance<br>5.a sense of purpose in life<br>6.sense of environmental | 24 indicator | 1.( safety and crime, political and economic stability, business condition,...)<br>2.(proactive policies, availability of good and services,...)<br>3.(education, hygine, health care, culture, years of schooling,...)<br>4.(environment, climate, access to nature, environmental issue,..)<br>5.(public transportation, international connectivity)<br>6.(urban design, quality of architecture, effective infrastructure in a city) | Recognize the different measurable criteria for the assessment of liveability in Skopje city |
| G. ] | Malaysia and Singapore | World Bank report 2005-2014 | 4 index | 1. economic<br>2.environmental<br>3. institutional<br>4.social<br>3. goverence political | 121 indicator | 1.( Economic Performance, Economic Openness, Infrastructure)<br>2.( Pollution, Depletion of Natural Resources, Environmental Initiatives) | provide a holistic comparison of Malaysia and Singapore in terms of national economic competitiveness, urban standards of living and quality of life. |

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| | | | | | | 3.( Crime Rate, Threats to National Stability, Civil Unrest)<br><br>4.( Medical & Healthcare, Education, Housing, Sanitation & Transportation, Income Equality & Demographic Burden, Diversity & Community Cohesion)<br><br>5.( Policy Making & Implementation, Government System, Transparency & Accountability, Corruption) | |
| 3[31] | Wuhan (China) | Survey and Expert opinion | 6 index | 1. Community Convenience<br><br>2. Community Environment<br><br>3. Community Civilization<br><br>4. Community Management<br><br>5. Community Security<br><br>6. Community Resource Conservation | 30 indicator | 1.( Traffic service facility, Commercial service facility, Cultural and sports facility, Healthcare facility)<br><br>2.( Ecological environment, Landscape environment, Hygienic environment)<br><br>3.( Resident diathesis, Community culture, | livable community evaluation indexes are evaluated based on GIS and fuzzy comprehensive evaluation method |

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| | | | | | | Community participation)<br><br>4.( Management tool, Community service)<br><br>5.( Public security, Safety device)<br><br>6.( Rainwater system design, renewable energy utilization) | |
| ] | 40 major cities in China | questionnaire surveys (2015) | 6 dimensions | 1.Urban security<br><br>2.Convenience of public facilities<br><br>3.Natural environment<br><br>4.Sociocultural environment<br><br>5.Convenient transportation<br><br>6.Environmental health | 29 indicators | 1.(a. social security, b. transport security, c. emergency shelters, d. disaster response capacity)<br>2.(a. shopping facilities, b. education facilities, c. healthcare facilities, d. dining facilities, e. recreational facilities, f. culture facilities, g. aged facilities)<br>3.(a. favorable climate, b. access to water area, c. access to urban parks, d. urban green coverage rate, e. cleanliness of city)<br>4.(a. high-quality citizens, b. social inclusion, c. urban | To explore the characteristics of satisfaction with urban livability and the effect magnitude of its determinants in China |

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| | | | | | | identity, d. protection of historical culture, e. sense of belonging)<br>5.(a. urban road conditions, b. access to public transit, c. availability of parking lots, d. traffic congestion)<br>6.(a. water pollution, b. solid waste pollution, c. air pollution, d. noise pollution) | |
| ] | Guangdong Province, China | questionnaire | 6 indexes | 1.community space<br>2.community environment<br>3.community service<br>4. community security<br>5.community life<br>6.community management | 17 factors | 1.(a. living conditions, b. ancillary facilities, c. traffic system)<br>2.(a. greening, b. sanitation, c. environmental protection)<br>3.(a. government service, b. integrated services, c. family planning service, d. property service)<br>4.(a. public security management, b. fire safety management, c. dispute resolution)<br>5.(a. cultural activities) | Figure out the livability of each community and present some advice. |

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| | | | | | | 6.(a. community autonomy, b. organizational structures, c. financial support) | |
| ] | Beijing, Tianjin, and Hebei in China | panel data (2010-2016) | 5 indexes | 1.amenity<br>2.convenience<br>3.happiness index<br>4.development level<br>5.safety index | 22 factors | 1.(a. days with air quality equal to or above Grade II, b. sewage treatment rate, c. green coverage rate in built up area, d. endowment insurance coverage rate, e. number of beds in hospital per 10000 population)<br>2.(a. road area per capita, b. number of public transportation vehicles per 10000 populations, c. internet subscriber coverage rate, d. domestic water consumption per capita)<br>3.(a. average yearly income-to-housing price ratio, b. average house price, c. average wage of non-private sector employees, d. | To evaluate the spatial-temporal characteristics of livability levels in Beijing, Tianjin, and Hebei from 2010 to 2016. |

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| | | | | | | surveyed unemployment rate)<br>4.(a. GDP per capita, b. proportion of tertiary industry in GDP, c. disposable income per capita, d. number of primary school students per 10000 population, e. number of library books per 10000 population, f. number of patents per 10000 population)<br>5.(a. criminal rate, b. area affected by drought, c. area affected by hail disasters) | |
| ] | Beijing, China | survey data (2017) | 5 indexes | 1.the health of urban environment<br><br>2. the safety of the urban<br><br>3. the openness of space<br><br>4. the inclusiveness of society<br><br>5. the vitality of culture | 30 factors | 1.(a. annual concentration of PM2.5, b. safety of water supply, c. sewage treatment rate, d. forest coverage rate)<br>2.(a. unemployment rate, b. criminal rate, c. number of deaths per 10000 cars, d. fire death rate)<br>3.(a. area of park green space per | Taking Beijing as an example, compared with the livable levels of New York, London and Tokyo which are world cities |

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| | | | | | | capita, b. network speed, c. number of internet subscribers per 100 population, d. track density within 15 km buffer)<br>4.(a. average education years, b. fiscal expenditure on education, c. number of social organizations per 10000 population, d. fiscal expenditure on social security)<br>5.(a. number of universities ranking among the top 200, b. number of world heritage sites, c. number of cultural creativity industry practitioners, d. number of culture venues) | |
| ej<br>] | Khon Kaen<br>(Thailand) | Survey data<br>2003–2014 | 9<br>index | 1. Safety<br>2.Economy<br>3.Environment<br>4. Education<br>5. Health<br>6. Transportation<br>7.Recreation | Null | 1.( location of police station and disaster prevention)<br>2.( land cover in the study area)<br>3.( location of both private and public hospitals) | develop a Liveable City Index (LCI) and generate a Liveable City Zonation Map(LCZM) |

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| | | | | 8.Population Density<br><br>9.Public Utility | | 4.( locations of main roads and highways.)<br><br>5.( locations of mobile network towers)<br><br>6.( locations of a total of 198 academic institutes)<br><br>7.( locations of the convenience store chain)<br><br>8.( data on the total population)<br><br>9.( locations of recreational spots) | |
| i, | Tehran | The High Council of Urban development and Architecture, 2010 | 3<br><br>indexes | 1. Social<br><br>2. Economic<br><br>3. Environmental | 16<br><br>indicators | 1. (a. Education, b. Social interactions, c. Participation, d. Access to everyday needs, e. Cultural and historical factors, f. Health, g. Security, h. Sense of place, i. Public spaces)<br><br>2.(a. Housing, b. Employment, c. Urban infrastructure, d. Diverse and desirable transportation)<br><br>3.(a. Air quality and pollution, b. Green spaces and parks, c. | spatial analysis of the districts of Tehran Metropolis in order to measure the livability |

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| | | | | | | Good urban landscape) | |
| ] | Wuhan(China) | taxi trajectory data, POI data, geographic conditions census data | 4 indexes | 1.life convenience<br>2.travel convenience<br>3.environmental comfort<br>4.residential safety | 18 indicator | 1.(a. educational facilities, b. commercial services facilities, c. medical welfare facilities, d. recreational sport facilities, e.other public facilities)<br>2.(a. public transport facilities, b. road facilities, c. traffic hotspot)<br>3.(a. community activity, b.community water, c.community Greenland, d.residential rank, e. building density, f.noise, g. air quality, h. key pollution source)<br>4.(a. firefighting agencies, b. police organization) | construct dynamic evaluation method of community livability from life convenience, travel convenience, environmental comfort and residential safety, dynamically evaluate community livability of the main urban areas in Wuhan |
| ban<br>] | Kolkata(India) | Census and Handbook data 2011 | 8 index | 1. Housing<br>2. Employment & Income<br>3. Educational facilities | 23 indicator | 1.(a. Housing density, b. Population density, c. Housing accessibility, d. Access to public amenities, e. | assess livability variations of constituent urban centers within Kolkata Metropolitan Area (KMA) based on Integrated Urban Geographic Factors (IUGFs). |

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| | | | 4. Health and social services<br><br>5. Public open space<br><br>6. Transportation facilities<br><br>7. Leisure and culture<br><br>8. Crime and safety | | Percentage of urban population living in slums)<br><br>2.(a. Employment rate, b. Economic opportunities)<br><br>3.(a. Availability of educational institutions, b. Quality of educational facilities, c. Number of schools)<br><br>4.(a. Availability of health facilities, b. Quality of health care,<br><br>c. Number of health care's)<br><br>5.(a. Percentage of open spaces, b. Availability of public spaces)<br><br>6.(a. Convenient transportation options, b. Convenient transportation options, c.Transportation costs)<br><br>7.(a. Number of recreational center, b.Accessibility to recreational center, c. | |

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| | | | | | | Conditions of recreational center)<br>8.(a. Number of police station, b. Level of security and safety) | |
| ] | 20 cities in Jiangsu, Anhui, and Henan Province, China | statistical data (2016) | 4 indexes | 1.economic development<br>2.population situation<br>3.resources<br>4.environment | 8 indicators | 1.(a. GDP per capita, b. number of industrial enterprises, c. total industrial output value)<br>2.(a. population covered by basic pension insurance, b. population covered by basic health insurance)<br>3.(a. fiscal expenditure on education, b. number of ordinary secondary schools)<br>4.(a. highway passenger capacity) | Rank the livability of 20 cities, and classify into 3 livability level by cluster analysis. |
| ] | 16 cities in Anhui Province, China | statistical data (2017) | 4 indexes | 1.economic development<br>2.infrastructure<br>3.ecological environment<br>4.livelihood issues | 11 indicators | 1.(a. GDP per capita, b. local finance revenue, c. number of listed companies, d. disposable income per urban resident)<br>2.(a. number of public transportation vehicles at year-end, b. number of beds in | Establishes a comprehensive evaluation model of urban livability level, and obtains the livability construction of 16 cities in Anhui Province. |

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| | | | | | | hospital per capita, c. number of universities, colleges, and secondary schools)<br>3.(a. average water resource per capita, b. afforestation area)<br>4.(a. living space per capita, b. educational finance) | |
| [78] | 5 cities in the northwest China (Xi'an, Lanzhou, Xining, Yinchuan, Urumchi) | statistical data from yearbook (2011-2016) | 5 indexes | 1.economic environment<br>2.ecological environment<br>3.residential environment<br>4.infrastructure<br>5.social environment | 24 indicators | 1.(a. GDP per capita, b. average wage of employee, c. fixed asset investment in urban area, d. total retail sales of consumer goods)<br>2.(a. area of park green space, b. domestic garbage harmless treatment rate, c. sewage treatment rate, d. green coverage rate in built up area, e. utilization rate of industrial solid waste)<br>3.(a. road space at year-end, b. persons per mobile phone subscriber at year-end, c. persons per internet subscriber, d. | Comparison of advantages and disadvantages among cities under different indicators. |

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| | | | | | | number of public transportation vehicles at year-end, e. number of taxis at year-end, f. green area)<br>4.(a. number of hospitals and health centers, b. length of drainage pipeline, c. number of schools, d. number of library books)<br>5.(a. registered unemployment rate in urban area, b. population covered by pension insurance, c. proportion of fiscal expenditure on technology and education, d. population covered by medical insurance, e. population covered by unemployment insurance) | |
| | Xinyang City, Henan Province, China | statistical data (2016-2018) | 6 indexes | 1.social civilization<br>2.economic development<br>3.environmental health | 28 indicators | | quantitative evaluation |

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| | | | | 4. resources sustainability<br><br>5.living amenity<br><br>6.public safety | | | |

Table 2: Technique for evaluation of Urban Liveability in the included studies

| | First Author/ Publication year | Language of Article | Technique | Evaluation Model |
|---|---|---|---|---|
| 1 | Chen, 2000[16] | Chinese | Based on the principles of safety, comfort, harmony and convenience, the author puts forward the basic framework of evaluation in terms of the indexes system | Weights were assessed by Delphi method based on survey |
| 2 | Balsas, 2004[38] | English | Null | Qualitative methods |
| 3 | Li, 2006[39] | Chinese | Defines the livable city and analyzes it's essence in the aspects of economy, society, culture, living, ecology, safety | Null |
| 4 | Zhang, 2007[40] | Chinese | Evaluatives framework of 5 index systems, including convenience, amenity, health, safety and community | Null |
| 5 | Chen, 2008[41] | Chinese | Applies subjective method to appraise living environment based on large-scale survey | Analytical hierarchy process (AHP) |
| 6 | Huang, 2008[22] | Chinese | Expert opinion (6 subjective evaluation indexes) | Analytical hierarchy process (AHP) |
| 7 | Ren, 2008[42] | Chinese | Quantifies urban residential suitability based on survey data | Analytical hierarchy process (AHP) and Q cluster analysis method |
| 8 | You, 2008[43] | Chinese | Resting upon the studies on the connotations of and relevant researches on “Livable City” | Factor analysis based on SPSS 13.0 |
| 9 | Luo, 2009[23] | English | Studies the livable environment on two scales | Factor Analysis and AHP |
| 10 | Dong, 2009[44] | Chinese | Establishes 5 subsystems by document analysis method and expert opinion | Determines weight of indicators by AHP and Delphi method. |
| 11 | Zhao, 2009[33] | Chinese | Establishes the objective evaluation index system of city inhabitable environment quality based on comprehensive reference | 5 level standards were set up based on related standards of civilization and ecotypic garden city construction; designs a model based on BP neural networks to measure the levels |
| 12 | Wang, 2009[45] | Chinese | Based on “Livable City Scientific Evaluation Standards (2007)” | comprehensive marking method |
| 13 | Lei, | English | Applies AHP method to determine the level of livability and ecology of Tianjin. Then, | Analytical Hierarchy Process (AHP) |

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| | 2010[21] | | comparing analysis is made on LIVABLE-CITY INDEX and ECO-CITY INDEX system, weighing and final scores. | |
| 14 | Dong, 2010[46] | Chinese | Establishes 5 subsystems by document analysis method and expert opinion | fuzzy mathematical model, and determines weights by expert opinion, AHP and Delphi method |
| 15 | Xi, 2010[47] | Chinese | Evaluates the buffer zones of park, school, supermarket, urban traffic main road and industrial district by RS and GIS technology | Grades livability into 7 degrees according to the benefits and harms of the residential environment |
| 16 | Yang, 2010[48] | Chinese | Based on relevant research at home and abroad, emphasizes the concept of 'a city for people'. Conducts an index system consisting of three different layers – objective, criteria and index. | TOPSIS and AHP methods |
| 17 | Shuai, 2010[49] | Chinese | Analyzes via the perspective of climate and environment based on "Livable City Scientific Evaluation Standards (2007)" | Delphi method |
| 18 | Li, 2010[25] | Chinese | Based on "Livable City Evaluation Indicator System of Scientific Research (2006)", and physical truth of Chongqing | Principle Component Analysis (PCA) |
| 19 | Liu, 2010[50] | Chinese | conducts evaluation systems for comparative study | AHP |
| 20 | Wang, 2011[51] | English | The livable level integrated index (LLII) | The linear weighted sum was applied as the assessment model. |
| 21 | Newton, Peter W 2012[52] | English | the liveability–sustainability nexus is explored using the two indices that have been most widely applied internationally: the Economist Intelligence Unit's Quality of Life rankings (the surrogate for liveability) (EIU, 2009) and the Global Footprint Network's Ecological Footprint measure of consumption (the surrogate for environmental sustainability) (WWF, 2010) | the Economist Intelligence Unit's Quality of Life rankings (the surrogate for liveability) (EIU) |
| 22 | Liu, 2012[53] | Chinese | Combines mass participation with expert argumentation | Null |
| 23 | Fu, 2012[54] | English | Evaluations systems of urban livability composed of target level, criterion level; factor level and index level was established according to the concept of residential environment of convenience, amenity, health and safety put forward by World Health Organization. | The livable scores were obtained by combining Mean Square Deviation Method and Principle Component Analysis Method to determine the index weights. |
| 24 | Wang, 2013[55] | Chinese | Indicators selected by statistical method, theoretical analysis method, and Delphi method | Data standardization and principal component analysis; |

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| | | | | Weights including 3 layers:<br>in index layer, each indicator has the same weight; in criterion layer, weights were determined by AHP and Delphi method; in goal layer, weights were summed by the criterion layers. |
| 25 | Chiang, Chia-Ling<br>2013[20] | English | the study built an evaluation index system that includes environmental aspects to quantify the livable urban environment in a city. | Analytical Hierarchy Process (AHP) the ELECTRE III method, and the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) |
| 26 | Okulicz-Kozaryn, Adam<br>2013[56] | English | Investigates the correlation between the popular Mercer city ranking (livability) and satisfactions. | Mercer city rankings |
| 27 | Li, W. Y.<br>2013[57] | English | constructs a two-stage qualitative analysis model and to create a method for evaluating livable city index weights for Taiwanese cities | the Fuzzy Delphi Method (FDM) and analytical hierarchy process (AHP) Factor Analysis |
| 28 | Safavi Sohi, M.<br>2014[58] | English | Descriptive review of research is done by experts' ideas. | content analysis |
| 29 | Pandey, Rama U<br>2014[59] | English | In the first step, focus group and the second step, questionnaire was then developed for inhabitants, for rating the selected list of indicators by professionals to capture their outlook on importance of each indicator in achieving desired livability in residential colonies. | focus group and survey questionnaire |
| 30 | Saitluanga, Benjamin L<br>2014[26] | English | Using data reduction method, levels of objective and subjective dimensions of livability are measured at neighborhood level. | principal component analysis (PCA) |
| 31 | Tan, Khee Giap<br>2014[34] | English | Uses a newly developed Global Liveable Cities Index (GLCI), with equal weights on every category. | The Global Liveable Cities Index (GLCI) |
| 32 | Jomehpour, Mahmoud | English | assesses the livability level of District 22 of Tehran and measures determined indicators | Pearson's correlation coefficient test. |

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| | 2015[60] | | | |
| 33 | Marsal-Llacuna, M. L. 2015[28] | English | Use of real time data instead of historical statistic for measuring liveability in smart Barcelona city | Principal Component Analysis(PCA) |
| 34 | Norouzian-Maleki, S. 2015[61] | English | open-ended questionnaire which is performed in four rounds. | Delphi method |
| 35 | Jones, C. 2015[62] | English | examining characteristics of liveable cities according to some of the widely reported liveability indices, such as those produced by Mercer, Monocle magazine and the Economic Intelligence Unit (EIU) | the EIU liveability index |
| 36 | Pampanga, D. G. 2015[63] | English | three-round blind survey generic Delphi toolkit method was conducted to pre-qualified 20 expert stake holders from Metro Johor | Delphi method |
| 37 | Lowe, M. 2015[19] | English | consultation workshops and feedback sessions with Melbourne-based academics, government policymakers, and community and private sector decision-makers | Mercer Quality of Living Survey and the Economist Intelligent Unit’s Liveability Index |
| 38 | Tan, 2016[64] | English | The Global Liveable Cities Index (GLCI) | Each indicator has the same weight in GLCI. (Analysis in 8 steps) |
| 39 | Md Dali, N. 2016[65] | English | This research Combined methodologies involving Focus Group Discussions, Interviews and Perception surveys. | Focus Group Discussions Perception surveys |
| 40 | Antognelli, Sara 2016[66] | English | a combination of GIS techniques (euclidean distance, kernel density estimation, network analysis, viewshed analysis), implemented in software (QGIS, PostGIS and PostgreSQL), were integrated with their percentage weights on liveability deriving from stakeholders interviews. | Analytical Hierarchy Process (AHP) |
| 41 | Huang, 2016[67] | English | The Triple Bottom-Line concept of sustainability emphasizes the balance among the three dimensions—environment, economy, and society. | Each indicator was calculated by mathematical formulation, separately |
| 42 | Dong, 2016[68] | Chinese | Based on “Livable City Scientific Evaluation Standards (2007)”, “National Garden City Standard (2005)” | AHP |
| 43 | Li, 2016[69] | Chinese | satisfaction with the degree of ecological livable | fuzzy comprehensive analysis, Delphi Method |
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| 44 | Tan, Khee Giap 2016[35] | English | uses a newly developed Global Liveable Cities Index (GLCI), to assess how Abu Dhabi ranks among global cities, with the same weight of each indicator. | The Global Liveable Cities Index (GLCI) and simulations analysis |
| 45 | Liu, 2017[5] | English | livability can be measured through the input of living conditions that have to fit the needs and capacities of urban residents based on a previous study (Veenhoven & Ouweneel, 1995) | Exploratory Factor Analysis |
| 46 | Jun, L. 2017[70] | English | Xianning City livability evaluation indicators system was made, on the one hand according to "livable city scientific evaluation standard" released by Chinese cities livability research group | qualitative and quantitative methods |
| 47 | Zhang, 2017[71] | Chinese | the study built an evaluation index system of world-class metropolis of harmony and livability from five dimensions, including city safety, life quality, natural environment, social harmony and open innovation | Weight of indicators was determined by AHP and Delphi method, referring to subjective evaluation of urban residents |
| 48 | Jia, 2017[29] | Chinese | Based on the “Livable City Scientific Evaluation Standards (2007)” | entropy analysis method and ArcGIS spatial analysis method |
| 49 | Tan, 2017[72] | Chinese | Based on the “Livable City Scientific Evaluation Standards (2007)” | Entropy method and analytic hierarchy process (AHP) were used to determine the weight of each index |
| 50 | Han, 2017[73] | Chinese | Based on the researches of Economist Intelligence Unit (EIU), WHO, Chinese Academy of Social Sciences. | 1.determining weights of Grade I indexes referring to EIU, weights of Grade II indexes by Delphi method 2. Exponential Smoothing method and Logistic model for predicting future scenarios. |
| 51 | Wu, 2017[27] | Chinese | Based on “Livable City Scientific Evaluation Standards (2007)” | principal component analysis and fuzzy C-means clustering analysis model |
| 52 | Liu, J. 2017[5] | English | A hierarchical framework for evaluating the livability is designed. The weight of each category defined by the EIU (2016). | Analytical Hierarchy Process (AHP) method |
| 53 | Sofeska, Emilija[30] 2017 | English | Data with survey acquired and spatial analysis | Spatial models |
| 54 | Tan, K. G. 2018[36] | English | To combine the various indicators with different units into one meaningful measure of competitiveness with the same weight and compare in terms of cost of living, | The Global Liveable Cities Index (GLCI) |

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| | | | wages, purchasing power and liveability. | |
| 55 | Yin 2018[31] | English | the GIS method is introduced to make an objective and fuzzy analysis for subjective indicator (qualitative analysis and quantitative analysis) | spatial analysis(GIS)<br>Fuzzy comprehensive evaluation |
| 56 | Zhan, 2018[32] | English | The geographical detector model is a spatial variation analysis method which has been widely used to identify the effect intensity of environmental factors on health outcomes. | geographical detector model |
| 57 | Chen, 2018[74] | Chinese | The Assessment Criteria for Livable Communities in Guangdong | AHP and Linear Summation Model |
| 58 | Cui, 2018[17] | Chinese | Based on “Livable City Scientific Evaluation Standards (2007)” | panel data model;<br>Weights of indicators determined by entropy method and AHP. |
| 59 | Huang, 2018[75] | Chinese | Based on the Maslow's Hierarchy of Needs Theory | Delphi method |
| 60 | Onnom, Worawej 2018[10] | English | Performed residents’ opinions and experts’ recommendations with the integration of Geographic Information System (GIS) techniques. | Liveable City Index (LCI)<br>Analytical Hierarchy Process (AHP) |
| 61 | Ghasemi, Kimia 2018[1] | English | Evaluates the livability of districts in Tehran , measured with respect to the fulfilment of biological needs | Standard deviational ellipse method(SDE)<br>the Analytic Hierarchy Process (AHP)<br>the Simple Additive Weighting (SAW) |
| 62 | Ning 2018[76] | English | Measures the equilibrium distribution of basic public service facilities within the community by spatial mean, construct dynamic assessment method of urban community livability based on time interval community hot spot and community activity | entropy weight method for determining index weight |
| 63 | Paul Arpan 2018[77] | English | Assesses livability variations of constituent urban centers based on Integrated Urban Geographic Factors (IUGFs), ‘K’ means clustering algorithm has been identified to delineate KMA into ‘K’ number of clusters. | K-means clustering |
| 64 | Liao, 2019[18] | Chinese | Considering the development level of livability in the Huaihe River eco-economic belt. | Factor analysis method |
| 65 | Tao, 2019[24] | Chinese | According to basic principles of factor analysis method, generalize several categories of indicators to reveal city livability level | Factor analysis method |
| 66 | Li, 2019[78] | Chinese | Based on former studies, constructing evaluation framework from natural and humane environment aspects. | Weight of indicators was determined by the entropy method. |

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| 67 | Cheng, 2019[7] | Chinese | From the perspective of human settlement, environment and the purpose of building livable cities. | AHP |

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# Figures

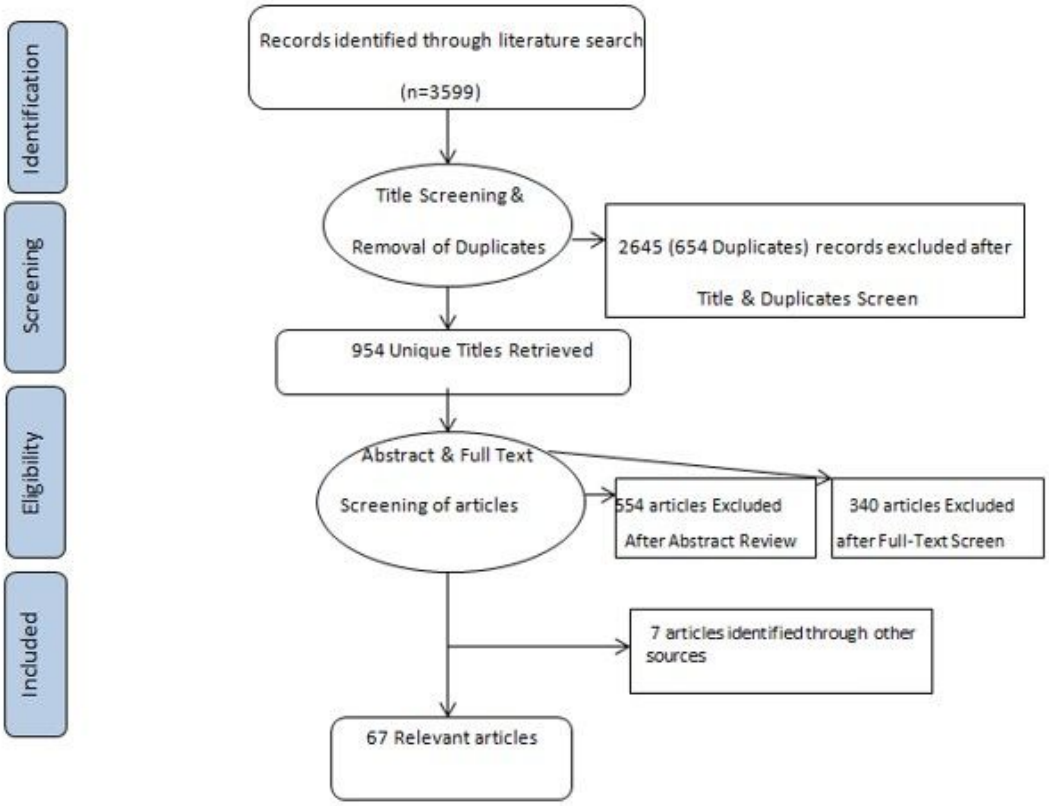


**Figure 1**

Flow chart of study selection in this scoping review

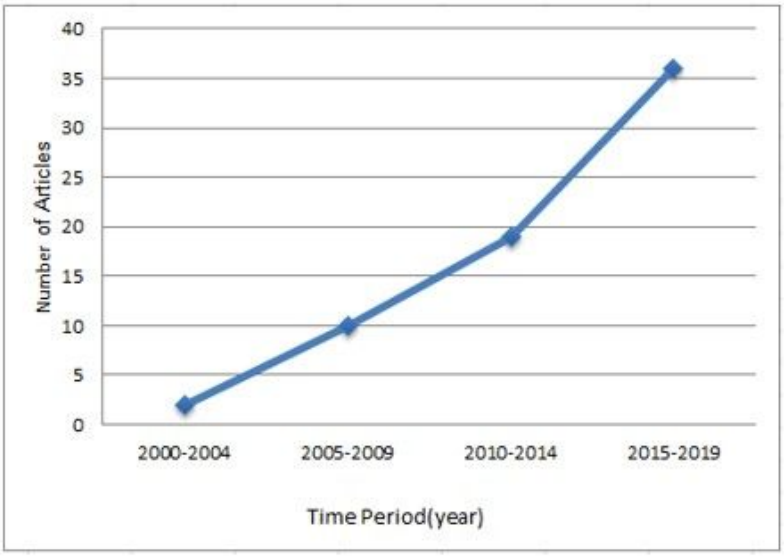


**Figure 2**

Distribution of Urban Liveability articles by publication year.

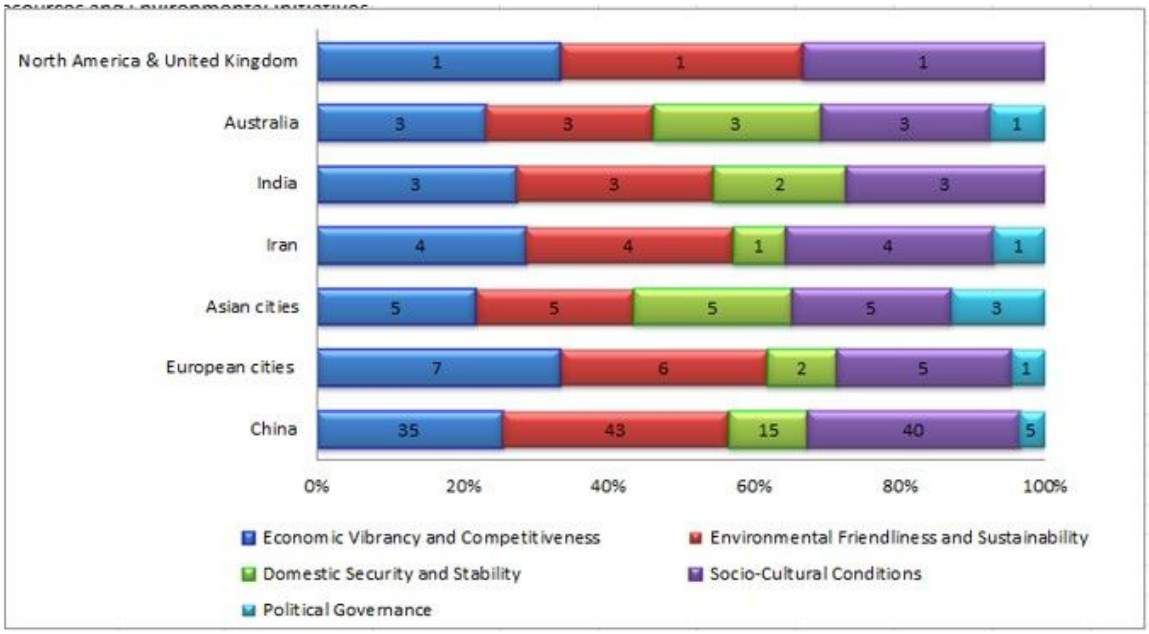


**Figure 3**

Distribution of included studies by scope and type of indicators

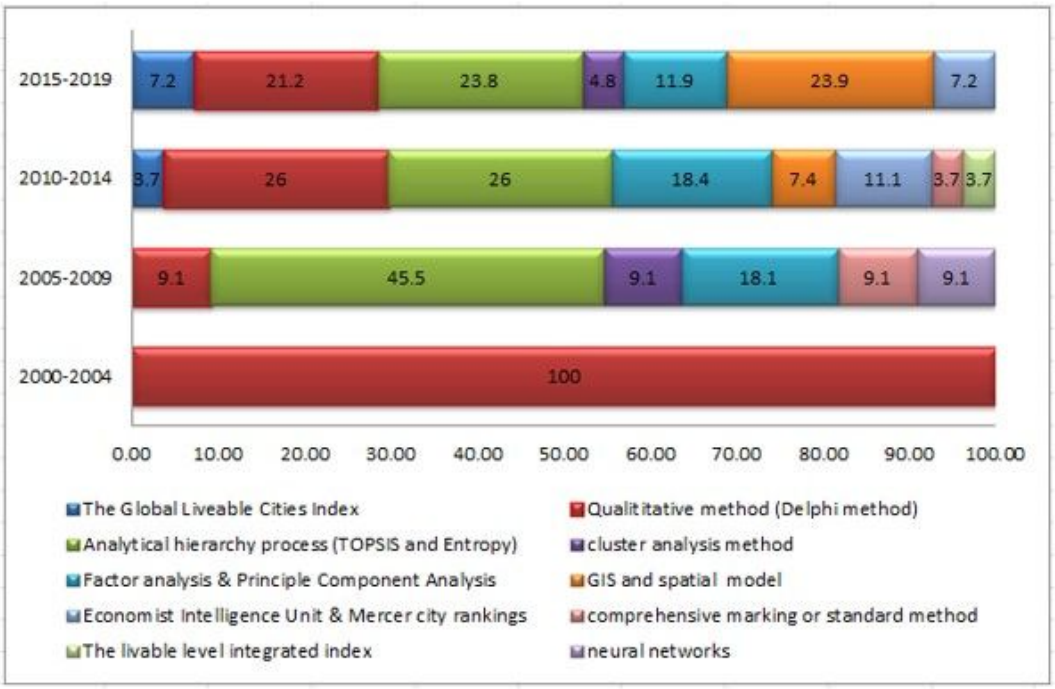


**Figure 4**

Distribution of included studies by year and type of the liveability Evaluation Model.

# Supplementary Files

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- AppendixI.docx