Livability- Analysis of People's Living Comfort in Different Cities of India Using GIS: A Prototype

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Abstract. The comfort of living for an average individual plays a crucial factor in urban development. It validates a city's ability to provide all the necessary comfort for modern livability standards. To analyze city livability, in this position paper we have proposed a system that provides a lifestyle overview through locality Indexing of a particular geographical area according to the ease of living for four particular age groups like a child, middle-aged, senior adult, and senior citizen. The system accounts for various indicators like health, transport, population, climate, pollution, crowd, etc. to yield a personalized result. The system consists of a web interface and a python backend which pulls desired data about the location from sources like Google Maps (Places API) and data.gov.in. (Indian Govt. website). This data is then mined and useful/relevant information is summarized to yield an end result. Parallel computations consisting of pattern discovery (by mining algorithms) and data aggregation are carried on a cloud service maintaining a local data store for processed queries. The generated end result is then presented to the user in the form of visualization charts.

Keywords: Livability · GIS · Locality indexing and analysis · Indicators

1 Introduction

Cities are emerging as the prime engines of the Indian economy. They are emerging as the generators of national wealth. India can be looked up to as one among the rapidly urbanizing nations in the world. According to the census report of 2017, India's urban population is 31.16% and there are 46 metropolitan cities [1]. It is necessary for the nation to invest in the social and economic functions of cities. As cities trace the path of Gross Domestic Product (GDP) growth rates by policies which adhere to the quality life, their comfort of living is highly challenged. Providing the person wanting to move to any city along with the complete knowledge of the surrounding of workplace, with least efforts is the main motivation of our project. Therefore, adapting the suitable job location (workplace) supports the person well-being [2].

The locality indexing or livability indexing is the sum of the factors that add up to a community's quality of life-including the built and natural environments, economic prosperity, social stability and equity, educational opportunity, cultural, entertainment and

recreation possibilities [3]. There can be various types or categories of indexing like physical and natural amenities. It largely depends on the class of the user who is assessing the locality. For example, some people need things to feel safe and secure. The rest might need good schools, transportation, hospitals and so on. Keeping this in mind, livability can be classified into different age groups, to provide a reliable result. Our system provides a lookout into the quality of life in a particular area or region or city as it accounts all the social, economic, environmental and civic factors that determine the possibility of a citizen to live in a city [4]. To get an in-depth idea of this project we have gone through several existing works, that consists of all the possible survey knowledge using Structural Equation Modelling (SEM) and Geographic Information System (GIS) approach.

2   City Livability Index and GIS

Livability encompasses broad human needs ranging from food and basic security to beauty, cultural expression, and a sense of belonging to a community or a place [3]. Nowadays, 31.16% of India lives in an urban area like towns and cities [5]. It is estimated that in the coming 20 years, nearly half of India would be shifting towards urbanized areas [5]. As a result, developing new cities for migration would be a major challenge. The City Livability Index 2010 [3] is a Government of India report which comments on the quality of life that our cities offer. It relies on entirely objective analysis, employing more than 300 indicators on a 10-year timeline series. For evaluating neighborhoods of Nigeria, a Structural Equation Modelling (SEM) approach has been introduced by Iyanda et al. [6]. This study employed a Delphi survey technique on fifteen livable human community experts in South Arica from which the conceptual variables for neighborhood features were developed for the study. A questionnaire survey was conducted among the residents of the selected low-income housing in South Africa. The data collected for the study were analyzed for factorial validity through SEM. The result obtained from the SEM analysis confirms only five indicators out of twenty-two indicators identified from the interview and literature review for the study. This study adopts structural equation modelling (a second order factor) to investigate the key factors of analyzing livability of planned residential neighborhoods in Minna, Nigeria. Using Geographic Information System (GIS) application tools, users can create interactive queries, information analysis, map data edition and display the results [7]. Therefore, we have used GIS to identify the livability index of a particular area.

3   Methodology

According to our survey, we have selected indicators that will fetch datasets corresponding to each of the indicators from sources like Google Places API [8], data.gov.in [9] and kaggle.com [10] into our environment and start standardizing it. Each of the datasets undergoes standardization and indexing in parallel until a raw figure that exhibits a particular indicator is obtained. These raw figures are then saved as variables which are reflected on the results page.

3.1   Identifying Indicators

During literature study from papers, government of India reports, we have identified several indicators are listed in Table 1 below. Livability is defined by a set of factors or

Table 1. Livability indicators

Features	Child (0-15)	MiddleAged (15-30)	SeniorAdult (30-50)	SeniorCitizen (>50)
Population	3	2	0	1
Migration	3	0	1	2
Education	1	0	2	3
Occupation	3	1	0	2
Health & Medical Standards	1	2	3	0
Health Parameter	1	3	2	0
Safety	2	0	1	3
Crime	3	2	0	1
Cyber Crime	2	0	1	3
Road Accidents	2	0	1	3
Housing Options	3	2	0	1
HousingCost & Availability	3	1	0	2
Urban House hold crowding	3	0	1	2
Socio Cultural Env	2	0	1	3
Political Env.	3	2	1	0
Infrastructure	2	0	1	3
Economic Env.	2	0	1	3
Income and employment	3	1	0	2
Economic Infrastructure	3	2	0	1
Business Env.	3	1	0	2
Purchasing Power	3	1	0	2
Planned Env. /City	3	2	0	1
Communication	3	0	1	2
Transportation Infrastructure	2	0	1	3
Labor Participation Rate	2	0	1	2
Open Space Index	2	3	1	0
Energy Index	2	0	1	2
Pollution	2	3	1	0
Climate	1	3	2	0
Food Quality	1	3	2	0
Food Variability	2	1	0	3
Food Availability	0	0	0	0
Water Availability	2	1	0	2
Water	3	2	1	0
Mobility Index	1	0	0	2
Night Life	3	0	1	2
Parking Facility	3	1	0	2
Availability of Public Transport	2	0	3	1
Traffic	3	0	1	2
Handicap Friendliness	3	2	1	0
Tourism Attraction	3	1	0	2

in this paper we called it as 'indicators.' Some of these indicators may carry varying significance for different age groups, which could be ranked among to yield personalized result. Table 2 shows how indicators are grouped and mapped accordingly in specific livability classes, where each class may/may not have some importance over the other. These grouped indicators aim to perfectly imply and achieve all the quality standards essential for current day assessment. Indicators are prioritized among four classes- Child, Middle Aged, Senior Adult, and Senior Citizen depicted in Table 2 [3].

Table 2. Reference Table for Table 1

Level	Importance
0	Highest
1	High
2	Low
3	Lowest

3.2 Fetching Datasets for Indicators

After identification of indicators, the Google Places API, data.gov.in and kaggle.com have used the fetch the dataset for a particular location.

3.3 Indexing Technique

There are different indexing methods [11] explained below. Data is indexed by calculating the following interpretations confined in the spectrum of data points as defined by the dataset.

Dimensional Index Methodology. This method normalizes all the data points within a fixed range (0, 1). This enables to sort and compare any given data points.

$$I = \frac{I(x) - I(\min)}{I(\max) - I(min)} \tag{1}$$

OR

$$I = 1 - \frac{I(x) - I(\min)}{I(\max) - I(min)} \tag{2}$$

For example: Open spaces (Indicator) – Max: 50%, Min: 5% Example of a Pune city where Open Space is 30%: (30-5)/(50-5) = 25/45 = 0.55 is Dimensional Index Methodology.

Z-Score or Standardization. This method classifies the datapoints across the median which helps in interpreting whether a given point has a positive/negative impact depicted in Table 3.

$$I = \frac{x - \mu}{\sigma} \tag{3}$$

Where,

$$\mu = \frac{1}{n} \sum_{n=1}^{\infty} x \, (mean) \tag{4}$$

$$\sigma = \sqrt{\frac{1}{n} \sum_{n=1}^{\infty} (x - \mu)^2} \tag{5}$$

(Standard Deviation)

Table 3. Z-score table

Z Score	Conclusion
Negative	Bad impact of that particular observation
Zero	No/Average impact of that particular observation
Positive	The good impact of that particular observation

Decile Scale Ranking. This method aggregately ranks all the datapoints using a calculated Decile Scale as shown below (Fig. 1).

Fig. 1. Decile scale calculation

D(n) = PERCENTILE (data_values[], n/10), where n = [1, 9], data values = array of values.

In the end, we can calculate the ranking of each state based on the values of the decile scale. Similarly, we can compute the rankings for all the indicators taken into account

and rank the cities accordingly [11]. The computed decile scale show in Table 4 below. Table 5 depicts the sample indexing method for an indicator. The sample indicators like Health Parameter, Safety, Crime etc. with their respective sample values (taken from datasets like Google Places API, data.gov.in and kaggle.com) taken for reference and their respective Dimensional Index Methodology, Z-score, Decile values were calculated as shown in the Tables 5 and 6.

Table 4. Decile scale

D1	D2	D3	D4	D5	D6	D7	D8	D9
63.89	65.98	68.05	70.12	72.19	75.43	78.66	83.02	88.51

Table 5. Example- sample indexing of an indicator

Sample indicator	Sample values	Dimensional index methodology	Z Score	Decile
Health parameter	67.02	0.162	-0.638	9
Safety	61.80	0.000	-1.053	10
Crime	72.19	0.323	-0.228	6
Cyber crime	94.00	1.000	1.504	1
Road accidents	80.28	0.574	0.415	2

Table 6. Relevant statistics

MAX	94.0
MIN	61.8
MEAN	75.1
STDEV	12.6

The above methods are used to calculate the livability index for different cities, which are also incorporated in the tool that we have proposed for livability analysis. The screen-shot of prototype designed is depicted below.

The screenshot of user interface of developed prototype for livability analysis is depicted in Fig. 2. This tool accepts the name of the place from the user and livability class as input. It displays the livability index of that particular place and also demonstrates each indicator rating in bar-chart format. In Fig. 3, upper right corner displays the livability index of *Jaipur* City and the bar-chart represents the indicators ratings. Below the bar-chart the relevant statistics like Population, Amenities, Climate etc. are displayed. The quick highlights of important factors of city livability.
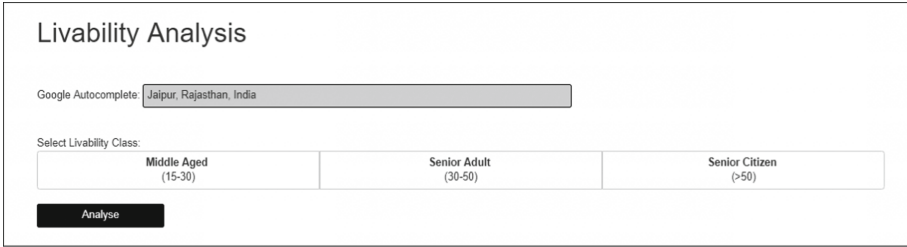
Fig. 2. The screen-shot-1 of tool's User Interface for Livability Analysis

Fig. 3. The screen-shot-2 of tool's User Interface for Livability Analysis

4   Conclusion and Future Scope

The present work is inspired by a web portal 'AARP Livability Index' [12], aiming to incorporate analysis for Indian regions. We have developed a tool (prototype) for calculating the livability index of Indian cities. Livability index support to find out users well-being for particular workplace or city. We work with different data sources to provide a similar, and a bit more enhanced experience that the existing solution by customizing the results based on the user-intended age group. A combined system that can fetch geographical data from sources and process it accordingly for the end-user to deliver a content-rich visualization is henceforth developed. We plan to refine the feature selection and classification process by using machine learning techniques to reduce complexity and to improve the exactness. This project has the potential to

evolve as a platform for city surveying and highlighting improvable sectors, which could stand useful for development planning at further stages. Lastly, we intend to make this application accessible to a broad group of end users by hosting it on a cloud service in the near future.

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