Spatial Pattern of Urban Livability in Himalayan Region: A Case of Aizawl City, India

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Abstract Cities are increasingly expected to provide impetus to the growth and development of their surrounding areas as well as to compete for economic activity with other cities. However, cities in developing countries are characterised by spatial differentiation and segregation due to widening inequality which are detrimental for growth and development of cities and regions. Concern over inequality in urban areas raises moral and ethical issues and demands compensatory and remedial policies to alleviate poorer places. This requires recognition of areas of relative deprivation at smaller scale through proper research. The present study is an attempt to find out patterns of inequality in livability in Aizawl-a fast growing hill city in the Himalayan region of northeastern India. Using data reduction method, levels of objective and subjective dimensions of livability are measured at neighbourhood level. The study found out that centrally located neighbourhoods are more livable in comparison to their peripheral counterparts. The study also found out that objective and subjective dimensions of livability have no significant relationship.

Keywords Urban livability · Neighbourhood inequality · Principal component analysis · Northeast India

1 Introduction

One of the manifestations of changing urban landscape in both developed and developing countries is emergence of socio-spatial differentiation and segregation. With increasing inequality, poorer people tend to get marginalised spatially in terms of their residential locations and of their activity spaces. Consequently, they suffer the most dangerous and polluted environment as well as the most restricted mobility and the worst access to services (Hall 2006).

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Livability is an "ensemble concept" (Myers 1988; Andrews 2001) with no precise or universally agreed-upon definition (NRC 2002). It has been used synonymously with quality of life (McCann 2007; Van Kamp et al. 2003; NRC 2002) and is also related to concerns for social well-being (Smith 1973). According to Pacione (1990) "livability is a quality that is not an attribute inherent in the environment but is behaviour-related function of the interaction between environmental characteristics and personal characteristics". However, definition of livability may differ from one culture to another and from time to time as the concept is relative "whose precise meaning depends on the place, time, and purpose of the assessment and on the value system of the assessor" (Pacione 2003).

Generally, livability is defined by performances in three main areas: environmental quality, neighbourhood amenity and individual well-being (Lennard and Lennard 1995). Environment has been conceptualised here as the sum total of physical, economic and social attributes where people are living. Therefore, urban livability may refer to the quality of urban environment that provides "human requirement for social amenity, health and well-being" at individual and community level (Newman 1999).

The study reported here examines spatial pattern of neighbourhood livability in Aizawl city in Mizoram, India. To the best of the author's knowledge, the present study is the first of its kind ever undertaken in hill cities of India.

2 Significance of the Study

Livability is becoming vital as cities and regions are increasingly expected to compete for economic activity with other cities and metropolitan regions throughout the world (Scott 1998). Cities are considered as "engines of growth" and city managers are re-examining the status of urban amenities so as to enhance their competitiveness or in other words, to facilitate "selling of places" (Kearns and Philo 1993). Secondly, quality of urban environment has been declining rapidly with increasing growth of population. Increasing livability of urban areas is seen as a method to reduce "ecological footprint", prevent pollution and conserve natural resources within cities and its surroundings. Thirdly, cities and urban areas are places of increasing inequality. Segregation of residents either on line of class, race or ethnicity has been becoming an important but unhealthy urban characteristic. Higher level of disparities in livability may generate deep dissatisfactions and underlie episodes of social unrest and dysfunction.

Concern over inequality in urban areas raises moral and ethical issues and demands compensatory and remedial policies to alleviate poorer places. This requires recognition of areas of relative deprivation at smaller scale through proper research. Studies on neighbourhood inequality have been encouraged as disparities are more visible and criticism of ecological fallacy is diminished at lower levels of aggregation (UN-HABITAT 2003). It has been maintained that neighborhood units are ideal units to assess intra-urban inequality in livability as issues of territoriality, identity, and well-being are attached to location (Morrison 2003; Moudon and Ryan 1994).

Besides, the present study will be helpful for planning purposes and policy actions as well as residential location decisions and choices. Moreover, it will have broad implications for patterns of regional migration, regional economic growth, and environmental sustainability (Kemp et al. 1997).

3 Objectives of the Research

The main objectives of the present study are:

1. To evaluate spatial pattern of urban livability in Aizawl city at neighbourhood level.
2. To identify dimensions and indicators of subjective and objective livabilities for Aizawl city at neighbourhood level.
3. To compare dimensions of objective livability and subjective livability.
4. To develop an overall index of urban livability for Aizawl city.

4 Hypotheses

Following the objectives, the following hypotheses have been formulated.

1. Levels of objective and subjective livabilities will differ from one neighbourhood to another.
2. Overall level of livability will be diminished from central business district (CBD) of the city to peripheral areas.
3. Overall level of livability of neighbourhood units will be affected by geographical features like hills and flat surfaces.
4. Objective and subjective dimensions of livability will correlate poorly.

5 The Study Area

Aizawl is the administrative capital of Mizoram which is located in the southernmost part of Northeast India. In 2011, the population of Aizawl was 291,822 and classified as Class I city as per the classification of urban centres in India. Presently, the city accommodates 26.74 % of the entire population of the state of Mizoram. The city consists of 19 municipal wards which comprises 85 local councils (LCs). These local councils are the lowest administrative units. Each local council unit is locally known as *veng*. Throughout this paper, terms like *veng*, locality and neighbourhood have been used synonymously.

Aizawl city was established in 1890 as a colonial outpost by the British Indian empire who invaded and occupied Mizoram. Initially, the colonial administrators enforced restrictions on immigration from outlying villages through imposition of tax called personal resident surcharge (PRS) on the residents. Thus, the city grew slowly during the colonial period and its population was about 7000 only in 1951. However, the city has witnessed spectacular growth rate in the post-colonial period and the population has reached almost 0.3 million in 2011.

As a part of the Patkai Hills of the Eastern Himalaya, the city sits on the crest of one of the number of small and elongated Mizo Hills running in North–South direction. The altitude of the city varies from 800 to 1,188 metres above mean sea levels. Some residential areas are steeply sloping areas and they hardly look inhabitable. Landslides frequently occur on these steeply sloping terrains when excessive Monsoon rain falls on the relatively young and immature soil. The average annual rainfall in the state is 2,350 mm out of which 60–70 % falls during the Monsoon period. Moreover, the entire Mizoram is one of the most earthquake-prone states in India.

Interestingly, Aizawl city is characterised by homogeneity in racial or ethnic composition with 91.95 % of the total population belongs to the local 'Mizo' tribe. Another important feature of the city is absence of large industrial unit and tertiary sector is the main employment provider.

6 Methodology and Literature Survey

6.1 Research Design

Firstly, a base map of the study area was prepared with the help of softwares like Arc view 3.2 and Surfer 9.1. Local councils (LCs) rather than municipal wards were selected as the unit of study due to their cohesiveness and presence of sense of community and integrity among its residents. Secondly, some objective data were obtained from government offices like Department of Economics and Statistics, Government of Mizoram and Registrar General, Census of India. Thirdly, due to unavailability of both subjective and crucial objective data from secondary sources at neighbourhood level, sample survey was taken out to collect primary data for both objective and subjective measures. To the best of our knowledge, this kind of survey was the first of its kind ever conducted in Aizawl city.

6.2 Sampling and Sample Size

Sample survey was taken out with utmost care to collect precise and reliable primary data. Various literatures were surveyed before taking sample to determine sample size and sampling method appropriate for the present study. In her study of quality of life in Guwahati, Assam, Das (2008) applied two stage stratified purposive sampling method. In the first stage, 6 municipal wards were selected out of 60 municipal wards purposively to represent various wards of the city. In the second stage, households were picked selectively from each ward to represent various income groups. In each ward, 3 % of the total households were interviewed to make a total of 379 samples.

In another important study, Tesfazghi et al. (2010) studied Kirkos sub-city, Addis Ababa by using purposive, stratified and systematic sampling methods to collect samples. Oktay and Rustemli (2011) employed multistage random sampling method to collect data in their study on quality of urban life in Famagusta, Northern Cyprus while Mozammel et al. (2011) studied quality of life in Dhaka by employing purposive stratified sampling method.

At micro level, Omuta (1988) studied quality of urban life at neighbourhood level in Benin City, Nigeria. Following Berry and Baker (1968), he adopted stratified random aligned traverse sampling method to take 1,410 sample households. Fakhruddin (1991) and Türkoglu et al. (2011) also employed random stratified sampling methods in their studies on quality of life at neighbourhood level in Lucknow and Istanbul respectively.

For the present study, random stratified sampling is used to generate a sample of households in various localities of Aizawl. Before the actual survey, a pilot study was taken out to test our structured questionnaires. On the basis of their responses, a refined questionnaire was generated. The following steps were taken to ensure well representation of different households within the whole city

1. Firstly, households from 6 Municipal Wards comprising of 27 local council (LC) units from central areas, middle areas and outer areas were selected. These wards constitute around 32 % of the total municipal wards. In terms of population, the study area constitutes 33.94 % of the total population of Aizawl city as per 2011 census.

2. Selection of households was also made to represent poorer households and wealthy households within each local council unit.
3. Respondents above 18 years of age were selected.

Sample size determination was taken out with extreme care. From each locality, a sample household of 5 % from the total household comprised the sample size. In the end, as many as 1,600 schedules were given out and face-to-face interviews were conducted by post-graduate students of the Department of Geography and Resource Management, Mizoram University during April to May 2012. Each schedule contained an information sheet mentioning that the identity of the respondents and his/her family should not be revealed and were free to decline answering the questions. The response rate was good i.e. 98 % since interviews were usually conducted during holidays and at night-time. Night-time visits are common among the local population and politeness to strangers is one of the traditional social norms of Mizo society. Only those households without any available person during the visits were skipped.

Based on previous studies on QOL and livability, a schedule was developed (Smith 1973; Omuta 1988; Das 2008; Mozammel et al. 2011). The schedule was designed to measure residents' perceptions and their evaluations about aspects of livability. The final schedule comprised of 46 questions covering various dimensions of livability.

Responses to each question were measured on a linear numeric version of a Likert-type scale. When items are to be judged on a single dimension and arrayed on a scale with equal intervals, a simple, linear numeric scale with the extremes labeled appropriately is the most statistically appropriate method of scaling. Whereas the traditional Likert-type scale produces only ordinal data and is thus inappropriate for parametric statistics, linear-numeric scales lead to equal-interval data that may be analysed using the most powerful parametric statistics (Alreck and Settle 1995).

For the majority of the questions, respondents were requested to place a tick in one of the five boxes to indicate their level of satisfaction with each item on a five-point linear numeric version of a Likert scale, "1" standing for strong level of dissatisfaction and "5" representing a strong level of satisfaction.

6.3 Limitations of the Study

1. Both quantitative and qualitative dimensions identified in the present study are not definitive. Adding additional dimensions may help to identify other indicators of urban livability.
2. Respondents may provide incorrect answers depending on their personal integrity, aspirations, knowledge and other factors.
3. The study is limited by unavailability of some important secondary data suited to be incorporated into the model. The data used in the study are mainly primary data collected through sample survey. Absence of temporal data may reduce the scope of the study.

6.4 Quantitative Techniques

Factor analysis is one of the most preferred approaches for measuring urban socio-spatial differentiation (Knox and Pinch 2010). The technique is a multivariate data reduction method that derives a composite, 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, by mapping them, it is possible to reveal the spatial distribution and patterns of social conditions within the city.

In the present study, principal component analysis (PCA) is utilised as a technique to construct the index of livability in Aizawl city. The method is a special case of factor analysis. It transforms an original set of variables into a fewer new set of orthogonal (uncorrelated) variables called principal components. Mathematically, principal components are linear combinations of variables with weights in terms of their eigen vectors. These eigen vectors are derived from the correlation matrix of the variables. Each principal component is a linear combination of X's obtained as

$$\text{First PC}(P_1) = a_{11}x_1 + a_{12}x_2 + a_3x_3 + \cdots + a_{1n}x_n$$

$$\text{Second PC}(P_2) = a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \cdots + a_{2n}x_n$$

Likewise, the component score for subsequent components may be worked out as Pn. To calculate PCA, firstly, raw data are normalised with the following formula:

$$N_{ij} = 1 - \left[\text{Best } X_{ij} - \text{Observed } X_{ij}\right]/R$$

where $R = \text{Best } X_{ij} - \text{Worst } X_{ij}$, $i = $ ith observation and $j = $ jth local council units or 'veng'. In case of negative indicators, the lowest value is considered as the best value and the highest value as the worst value. The normalised data matrix is used for statistical analysis.

Secondly, factor loadings and weights are to be assigned to these normalised values. Principal component analysis (PCA) was used to compute the factor loadings and weights of the indicators. For this, statistical package for social scientists (SPSS) was employed to obtain initial eigen values which were more than one. These eigen values were used to obtain weights of the variables.

Thirdly, after weights were assigned to each indicator, an index was determined with the help of the following formula:

$$I = \sum X_i \left(\sum |L_{ij}| . E_j\right) \Big/ \sum \left(\sum |L_{ij}| . E_j\right)$$

where I is the index, X_i is the ith indicator, L_{ij} is the factor loading of the ith variable on the jth factor; E_j is the eigen value of the jth factor.

The above procedure was followed to obtain indices of all dimensions of livability like economic, social, household and accessibility dimensions as well as two subjective dimensions like satisfaction from neighbourhood's socio-economic environment dimension and satisfaction from neighbourhood's physical and infrastructural dimension. Treating the obtained indices as variables, PCA was run again on SPSS to obtain overall index of livability. Based on the index, rank was assigned to each *veng* and choropleth map was prepared to show the spatial pattern of livability in the study areas.

Apart from PCA, descriptive statistics like mean and standard deviation were calculated. Pearson's product moment correlation was applied to test the relationship between objective indicators and subjective indicators.

6.5 Dimensions and Indicators of Livability

An important aspect of urban livability is that it comprises both objective and subjective measures. For many years, scholars have been arguing that "quality" of any entity has a subjective dimension that is perceptual as well as having an objective reality (Marans and

Stimson 2011). Objective indicators alone are considered inadequate to measure livability because satisfaction, an important component of livability is an assessment of perceived discrepancy between one's aspirations and achievement. On the other hand, subjective indicators cannot represent the environmental condition in which people live. Therefore, both subjective and objective measures are suggested to find out pattern of urban livability or quality of urban life (Milbrath 1979; Andelman et al. 1998).

Different scholars have identified several domains related to quality of life, social well-being and inequality. Smith (1973) focused on six criteria to assess social well-being: economic status, environment, health, education, social disorganisation, and participation and equality. Pacione (1995) derived social, demographic and economic dimensions from a list of 64 variables. Omuta (1988), on the other hand, identified five objective dimensions like employment, housing, amenities, nuisances and socio-economic dimensions as well as one subjective dimension which is perceived environment. Kearns et al. (2000) has given six deprivation dimensions like housing, crime/environment, health, education, labour market and poverty. Leby and Hashim (2010) proposed four dimensions of livability including social, physical, functional, and safety dimensions in their study on Selangor, Malaysia.

Dimensions of urban livability may vary from place to place and from one person to another. Selection of indicators depends on the socio-economic attributes and physical environment of the study area as well as objectives of the researchers (Van Kamp et al. 2003; Pacione 2003). In the present study, six broad dimensions have been identified to represent the economic conditions, social well being and the environment. They are four objective dimensions including economic, social, household and accessibility dimensions and two subjective dimensions which are satisfaction from socio-economic environment and satisfaction from physical to infrastructural environment dimensions. These livability dimensions have to be converted into set of indicators that can be used for evaluation. The livability dimensions and their corresponding sets of indicators are given in Table 1.

7 Results and Discussions

7.1 Objective Dimensions of Livability

Assessment of urban livability is an important tool of evaluating spatial justice that concerns with the question of "who gets what, where and how" (Smith 1979). Most geographical inquiries on livability have been based on objective measures of environmental quality (Pacione 1990).

7.2 Economic Dimension of Urban Livability

Analysis of index of economic dimension of urban livability reveals that Zarkawt *veng* stands at the top of the ranking followed by Ramthar and Chanmari. It was also found out that there exists differences between the top ranked neighbourhoods and the least ranked neighbourhoods. It may be easily recognised from the Fig. 1 that the top three localities are lying in the central areas of the city while the bottom three are lying at the peripheries. The top ranked neighbourhoods like Zarkawt and Chanmari are the most expensive localities in Aizawl due to their favourable locations for commercial activities. In fact, residential buildings in these neighbourhoods are gradually transforming into commercial buildings due to stiff competition between the two land-uses. Residents in these neighbourhoods are normally businessmen, government officials and those who have settled from the time of

Table 1 Dimensions and indicators of urban livability

Dimensions	Codes of indicators	Definitions of indicators
Economic	INCOME	Average monthly income of households
	TERTIARY	Percentage workers in tertiary and service sectors
	BANK	Bank accounts per households
	INSURANCE	Insurance policy subscribed/households
	COMPUTER	Computers/households
	INTERNET	Internets/households
	2WHEEL	Two wheelers/households
	4WHEEL	Four wheelers/households
	MOBILE	Mobile phones/households
	LANDLINE	Landline telephones/households
	ELECTRIC	Average last month electricity bill
Social	HH SIZE	Average household size
	EDU 12	Percentage of population studied up to class 12
	SEX RATIO	Females/1,000 male
	SCHOOLS	Schools/1,000 population
	HEALTH	Health centers/1,000 population
	RECREATION	Recreational centers/1,000 population
	P_LIT	Percentage of total literacy rate
	F_LIT	Percentage of female literacy rate
	CHRONIC	Percentage of population having any chronic diseases
Household	RCC	Percentage of RCC buildings to total buildings
	OWNED	Percentage of owned households to total households
	RENT	Average rent per household
	ROOM	Average room per household
	LPG	Liquefied petroleum gas connections per households
Accessibility	ROAD	Average distance to main road
	CHURCH	Average distance to church
	PLAYGROUND	Average distance to playground
	BANK	Average distance to nearest bank
	HOSPITAL	Average distance to nearest health centre
Satisfaction from socio-economic environment	S_SCHOOL	Satisfaction from quality of schools in neighbourhood
	S_JOB	Satisfaction of job opportunities in neighbourhood
	S_UPCHILD	Satisfaction from quality of neighbourhood for upbringing of children
	S_CRIME	Satisfaction from incidence of crime within neighbourhood
	S_SAFETY	Satisfaction from safety of children and elders within neighbourhood
	S_COST	Satisfaction from cost of living in own neighbourhood
	S_PARTICIPATION	Satisfaction from participation in community activities within neighbourhood
	S_NEIGHBOURS	Satisfaction from intimacy with neighbours
	S_DISTRIBUTION	Satisfaction from problems of garage and water distribution within neighbourhood

Table 1 continued

Dimensions	Codes of indicators	Definitions of indicators
Satisfaction from physical and infrastructural environment	S_LEISURE	Satisfaction from availability of leisure and recreational places within neighbourhood
	S_PARK	Satisfaction from availability of playground and parks for children within neighbourhood
	S_CLEAN	Satisfaction from cleanliness of neighbourhood
	S_NOISE	Satisfaction from level of noise pollution within neighbourhood
	S_DISASTER	Satisfaction from safety from natural hazards
	S_TRANSPORT	Satisfaction from availability of public transport within neighbourhood
	S_MUNICIPAL	Satisfaction from municipality services within neighbourhood
	S_INFRAROAD	Satisfaction from condition of road within neighbourhood
	S_INFRAWATER	Satisfaction from distribution system of drinking water within neighbourhood
	S_INFRALPG	Satisfaction from distribution system of LPG within neighbourhood
	S_SLOPE	Satisfaction from slope of house site
	S_SUNLIGHT	Satisfaction from length of receiving sunlight

their ancestors. On the other hand, Phunchawng, Rangvamual and Sakawrtuichhun form the bottom three in the ranking of economic dimension. Neighbourhoods like Phhunchawng and Rangvamual were mainly occupied by new immigrants from Myanmar and other parts of the state. At the time of the sample survey, most families were engaged in traditional shifting cultivation and/or brewing and selling of local liquor (Table 2).

7.3 Social Dimension of Urban Livability

In terms of social dimension, Zarkawt veng which lies in one of the inner city areas of the city has the highest livability score mainly because of relatively higher scores in educational indicators like percentage of population who studied up to class 12 (EDU12), percentage of literacy rate (P_LIT) and female literacy rate (F_LIT) as well as number of health centres/ 1,000 population (HEALTH). Higher ranking of Zarkawt in social dimension may be explained by better economic status of the neighbourhood. Ramthar and Govt. Complex come in the second and third position respectively and showed relatively higher scores in educational sectors. These two neighbourhoods are located in the middle sector of the City.

   On the other hand, Tuithiang shows the lowest score in social dimension of livability. This locality, although located very near to the heart of the city, is showing relatively lower values in almost every indicators of social dimension except household size (HH SIZE). Localities like Phunchawng, Zemabawk, Rangvamual and Chawlhhmun also show relatively lower values of index of social dimension. These localities are located at the peripheries of the city.

7.4 Household Dimension of Urban Livability

As shown in Table 3, Zarkawt continues to be the most livable locality in terms of household dimension too. The neighbourhood shows relatively higher values in percentage of RCC
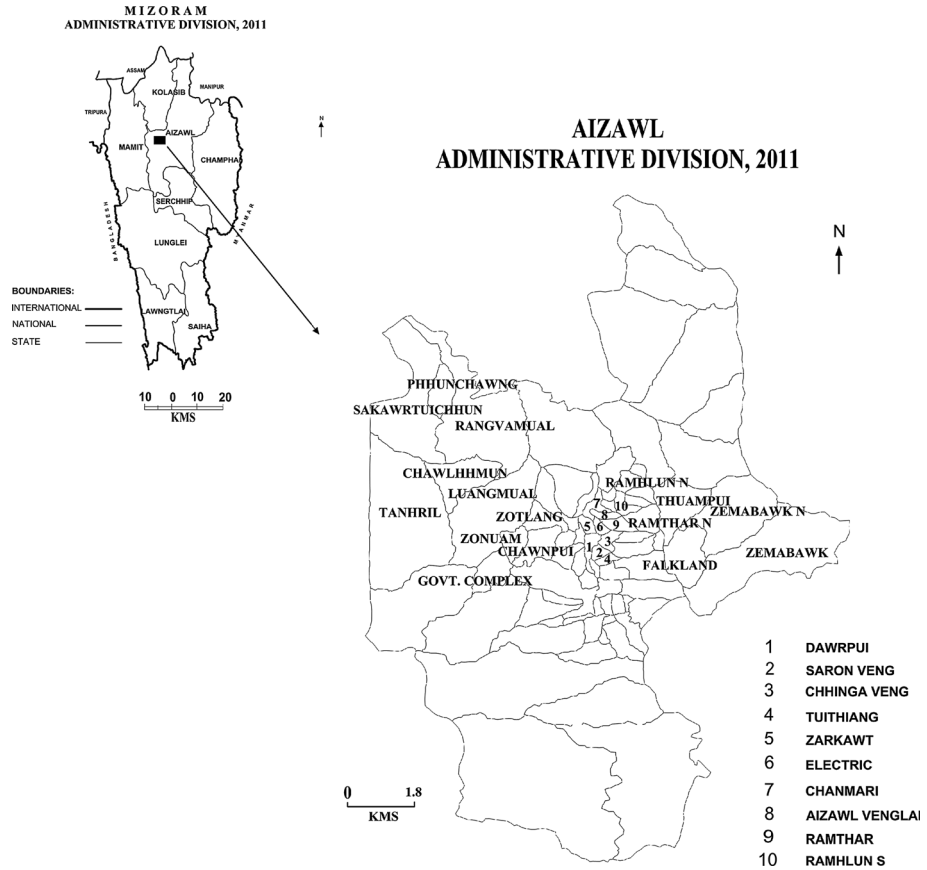
Fig. 1 Aizawl City

buildings and rent of households. The second highest locality, Ramthar North also shows higher values in indicators like percentage of RCC buildings, percentage of owned households, number of rooms per households and number of LPG connections per households. Other centrally located neighbourhoods like Dawrpui and Chanmari do not make into the top order mainly due to lower values of owned buildings (OWNED) and number of rooms (ROOM). In these high density areas, incidence of owned households was markedly lower in comparison to other localities. Most of the sampled households were rented households found on the basement of the buildings and are characterised by smaller sizes and fewer number of rooms.

On the other hand, peripheral localities like Phunchawng, Rangvamual and Tuivamit are found at the bottom of the ranking. These localities are characterised by absence of good buildings, lower rent values, less number of rooms and less number of LPG connections.

7.5 Accessibility Dimension of Urban Livability

Accessibility factors are important components of urban livability. In fact, they determine the level of infrastructural development and flow of movement. They also reflect the availability of time and space for everyday lives. Among the selected indicators, distance

Table 2 Classification of neighbourhoods in economic and social dimensions in Aizawl City

Class	Economic dimension		Social dimension	
	Range of values	Neighbourhood	Range of values	Neighbourhood
Very high	Above 0.699	Zarkawt	Above 0.641	Zarkawt
High	0.698–0.486	Ramthar, Chanmari, Falkland, Dawrpui, Ramhlun S, Electric, Chawlhhmun, Zotlang, Aizawl Venglai	0.640–0.545	Ramthar, Govt. Complex, Sakawrtuichhun, Aizawl Venglai, Chanmari, Zotlang, Ramhlun S, Electric, Chawnpui
Medium	0.485–0.274	Thuampui, Luangmual, Saron Veng, Chawnpui, Ramthar N, Ramhlun N, Chhinga Veng, Govt. Complex	0.544–0.449	Ramhlun N, Thuampui, Saron, Tanhril, Dawrpui, Falkland, Ramthar N, Tuivamit, Chhinga Veng
Low	0.273–0.062	Zonuam, Zemabawk N, Tuithiang, Zemabawk, Tanhril, Tuivamit, Sakawrtuichhun, Rangvamual	0.448–0.353	Zonuam, Zemabawk N, Luangmual, Chawlhhmun, Rangvamual, Zemabawk
Very low	Below 0.061	Phunchawng	Below 0.352	Phunchawng, Tuithiang

Table 3 Classification of neighbourhoods in household and accessibility dimensions in Aizawl City

Class	Household dimension		Accessibility dimension	
	Range of values	Neighbourhood	Range of values	Neighbourhood
Very high	Above 0.706	Zarkawt, Ramthar		
High	0.508–0.705	Ramhlun N, Ramthar N, Falkland, Chawlhhmun, Thuampui	Above 0.882	Chhinga Veng, Chanmari, Saron Veng, Zarkawt, Electric, Thuampui, Ramthar, Ramhlun N, Ramthar N, Dawrpui, Tuithiang
Medium	0.315–0.507	Electric, Luangmual, Dawrpui, Chanmari, Ramhlun S, Aizawl Venglai, Zotlang, Zonuam, Sakawrtuichhun	0.697–0.881	Aizawl Venglai, Ramhlun S, Govt. Complex, Luangmual, Zotlang, Zemabawk N, Zonuam, Tanhril, Rangvamual
Low	0.112–0.314	Zemabawk, Tanhril, Govt. Complex, Chawnpui, Saron Veng, Zemabawk N, Chhinga Veng, Tuithiang, Tuivamit, Rangvamual	0.511–0.696	Chawlhhmun, Falkland, Sakawrtuichhun, Tuivamit, Zemabawk
Very low	Below 0.111	Phunchawng	Below 0.510	Chawnpui, Phunchawng

to nearest bank (BANK) and distance to nearest health centre (HOSPITAL) have higher values of standard deviation since they were not located in every locality unlike other indicators. Coefficients of variation were relatively higher for HOSPITAL and distance to

nearest main road (ROAD) indicating the relatively lower density of these infrastructures in certain areas.

As expected, neighbourhoods located nearer to the Central Business District (CBD) like Chhinga Veng, Chanmari, Saron Veng, Zarkawt and Electric Veng are doing better in comparison to peripheral neighbourhoods like Phunchawng, Chawnpui, Zemabawk, Tui-vamit and Sakawrtuichhun.

7.6 Subjective Dimensions of Urban Livability

Subjective indicators are derived from surveys of resident's perception, evaluation and satisfaction with urban living. In his studies on quality of life in Taipei, Lee (2008) stated that quality must be subjective and the most appropriate method of exploring quality of life is by directly asking people about their perception. Subjective methods are preferred over objective methods, particularly for planning and policy purpose, as it is able to provide more valuable feedback (Ibrahim and Chung 2003). However, it may be noted that sub-jective indicators have lower reliability and higher validity than objective indicators) since resident's subjective perception of well-being is often affected by expectations (Foo 2000).

7.6.1 Satisfaction from Socio-Economic Environment Dimension

Socio-economic characteristics of development are usually measured in terms of objective indicators. It is, however, considered necessary to measure the perceived socio-economic environment of the residents that may help to reflect the ground realities more vividly.

Mean values in Table 4 show that half of the residents of Aizawl city were satisfied in their perceived socio-economic environment. Among the selected indicators of socio-economic environment, residents have shown highest level of satisfaction in their rela-tionship with neighbours (S_NEIGHBOURS) followed by availability of jobs within their neighbourhoods (S-JOB) and quality of schools (S_SCHOOL). On the other hand, they were least satisfied in their relationship with neighbours relating to garage and distribution of drinking water (S_DISTRIBUTION) followed by incidence of crime (S_CRIME) and cost of living (S_COST) in their respective neighbourhoods.

Table 5 shows that residents of Ramthar North, Ramhlun North and Zemabawk North have higher level of satisfaction in their socio-economic environment. It may also be noted that peripheral neighbourhoods like Zemabawk North, Thuampui, Zemabawk and Luangmual have been rated highly livable in terms of socio-economic characteristics by their residents while residents of centrally located neighbourhoods like Electric Veng, Dawrpui, Chanmari etc. were not highly satisfied enough on their socio-economic environment.

7.6.2 Satisfaction from Physical and Infrastructural Environment Dimension

Although Aizawl is known for its hilly and difficult terrains, majority of the residents were satisfied with their house sites and safety from natural hazards like landslide as indicated by the more than average mean value and the relatively lower value of coefficient of variation (CV) of S_DISASTER (see Table 4). Out of the five points Likert-scale, mean satisfaction level is the highest for S_SLOPE followed by S_TRANSPORT and S_SUNLIGHT.

Table 4 Descriptive statistics of indicators of subjective dimensions in Aizawl City

Dimensions	Indicators	Mean	SD	CV
Socio-economic environment	S_SCHOOL	3.74	0.35	0.09
	S_JOB	3.78	0.29	0.08
	S-UPCHILD	3.48	0.42	0.12
	S_CRIME	3.12	0.60	0.19
	S_SAFETY	3.59	0.45	0.12
	S_COST	3.14	0.34	0.11
	S_PARTICIPATION	3.19	0.28	0.09
	S_NEIGHBOURS	3.82	0.29	0.08
	S_DISTRIBUTION	3.05	0.77	0.25
Physical and infrastructural environment	S_LEISURE	2.50	0.45	0.18
	S_PARK	2.42	0.50	0.21
	S_CLEAN	2.08	0.85	0.41
	S_NOISE	2.40	0.92	0.38
	S_DISASTER	3.49	0.56	0.16
	S_TRANSPORT	3.76	0.39	0.10
	S_MUNICIPAL	3.44	0.38	0.11
	S_INFRAROAD	3.26	0.71	0.22
	S_INFRAWATER	2.84	0.49	0.17
	S_INFRALPG	2.33	0.49	0.21
	S_SLOPE	3.89	0.33	0.09
	S_SUNLIGHT	3.63	0.31	0.09

Table 5 Classification of neighbourhoods in subjective dimensions in Aizawl City

Class	Socio-economic environment dimension		Physical and infrastructural environment dimension	
	Range of values	Neighbourhood	Range of values	Neighbourhood
Very high	Above 0.794	Ramthar N, Ramhlun N, Zemabawk N	Above 0.669	Govt. Complex
High	0.636–0.793	Ramthar, Thuampui, Zemabawk, Luangmual, Electric	0.571–0.668	Electric, Zemabawk N, Rangvamual, Chanmari, Sakawrtuichhun, Tuivamit, Ramthar N, Chawnpui, Zarkawt, Dawrpui
Medium	0.477–0.635	Sakawrtuichhun, Dawrpui, Phunchawng, Govt. Complex, Falkland, Rangvamual, Zonuam, Chawlhhmun, Chawnpui, Ramhlun S, Tanhril, Tuivamit	0.473–0.570	Zemabawk, Chawlhhmun, Tanhril, Zonuam, Phunchawng, Ramhlun S
Low	0.318–0.476	Zarkawt, Chhinga Veng, Chanmari, Tuithiang, Saron Veng	0.374–0.472	Luangmual, Ramthar, Zotlang, Falkland, Ramhlun N, Thuampui, Tuithiang
Very low	Below 0.317	Aizawl Venglai, Zotlang	Below 0.373	Aizawl Venglai, Chhinga Veng, Saron Veng

On the other hand, residents of Aizawl city as a whole have shown lower satisfaction levels on availabilities of recreational places (S-LEISURE), playgrounds and parks (S_PARK) as well as distribution systems of drinking water (S_INFRAWATER) and cooking gas (S_INFRALPG). In fact, the city has only one park, one cinema hall and a handful of outdoor and indoor playgrounds which are highly insufficient for a population of almost three hundred thousand. Supplies of drinking water and cooking gas have been difficult and many households have resorted to private sellers and illegal market respectively.

It is interesting to note that both the centrally located and peripheral neighbourhoods were found among the top ranked districts in the two indices of subjective dimensions. One of the peripheral neighbourhoods, Rangvamual Veng which has been ranked consistently low in all the indices of objective dimensions has scored very high in this perceived physical and infrastructural environment. On the other hand, Zarkawt Veng, a highly ranked neighbourhood in subjective dimensions has found its place in the middle order of the ranking.

7.7 Overall Index of Livability in Aizawl City

After obtaining indices for all the six dimensions, overall index of urban livability has been computed. The obtained indices were treated as variables and their values were supplied into the SPSS and PCA is run again on the software. Based on the index, rank is assigned to each Local Council or neighbourhood unit. Table 6 shows the overall ranks of neighbourhoods.

Among the 27 sampled neighbourhoods, Zarkawt Veng comes out as the most livable neighbourhood. The neighbourhood ranks first in three dimensions viz social dimension, economic dimension and household dimension. Ramthar Veng is the second most livable neighbourhood followed by Electric Veng.

On the other extreme, Phunchawng Veng is the least livable neighbourhood followed by Tuithiang Veng and Rangvamual Veng. Phunchawng Veng and Rangvamual Veng are contiguous neighbourhoods located at the outskirts of the city. Provisions of Infrastructures and civic amenities were not good in these localities. The lower status of livability of Tuithiang Veng, on the other hand, is unexpected. This neighbourhood is located very close to the centre of the city or Central Business District (CBD) but ranks very low in all indices of dimensions of livability. Figure 2 depicts the spatial pattern of livability in Aizawl city.

8 Correlation between Objective and Subjective Dimensions

One of our objectives is to find out the relationship between objective and subjective dimensions of urban livability. It has been argued that the nature and strength of linkages between objective dimensions and subjective evaluations of the urban environment need to be tested as understanding them may be important in informing how planning and other policy interventions might contribute to improving the quality of urban life or livability (Marans and Stimson 2011). To find out the association of the different dimensions, values of various indices were taken as variables and correlation analysis was applied.

Table 6 Overall index of livability and ranks of neighbourhoods in Aizawl City

Veng	Livability index	Rank
Zarkawt	0.348804	1
Ramthar	0.325217	2
Electric	0.300253	3
Ramthar N	0.298502	4
Ramhlun N	0.292473	5
Dawrpui	0.286421	6
Chanmari	0.281474	7
Thuampui	0.280183	8
Falkland	0.269622	9
Ramhlun S	0.263606	10
Govt. complex	0.256545	11
Luangmual	0.254707	12
Chawlhhmun	0.254064	13
Zemabawk N	0.24723	14
Aizawl Venglai	0.236461	15
Zotlang	0.230876	16
Sakawrtuichhun	0.226126	17
Zonuam	0.221572	18
Saron Veng	0.220646	19
Chhinga Veng	0.217807	20
Tanhril	0.216187	21
Zemabawk	0.211349	22
Chawnpui	0.201691	23
Tuivamit	0.192742	24
Rangvamual	0.192346	25
Tuithiang	0.185533	26
Phhunchawng	0.135828	27

In Table 7, X1, X2, X3 and X4 indicate objective dimensions like economic index, social index, household index and accessibility index respectively. Subjective dimensions like socio-economic environment index and physical and infrastructural environment index are indicated by X5 and X6 respectively.

It may be seen from Table 7 that objective and subjective dimensions correlate poorly. Economic dimension is significantly correlated with all other subjective dimensions. On the other hand, it shows negative relationship with subjective dimensions. Satisfaction from socio-economic environment index (X5) shows positive relationship only with household index (X3) while another subjective dimension i.e. satisfaction from physical and infrastructural environment (X6) shows a very low positive relationship with social index (X2). It may also be seen that the two subjective dimensions are positively correlated but not significant even at 5 % level of significance. Therefore, it may be said that objective dimensions are positively correlated to each other but not with subjective dimensions. In other words, there is no positive relationship between subjective environment and objective environment.
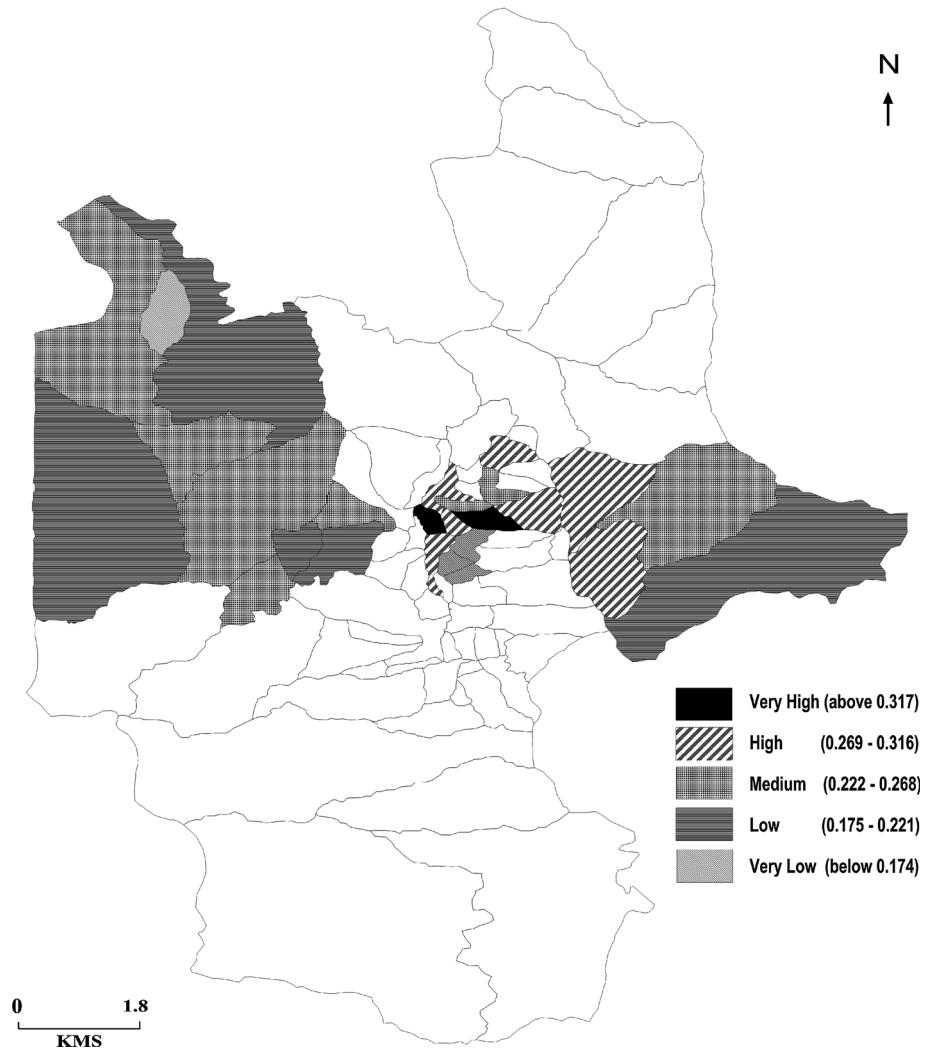
Fig. 2 Spatial pattern of livability in Aizawl

Table 7 Correlation matrix of objective and subjective dimensions of urban livability in Aizawl

Indicators	X1	X2	X3	X4	X5	X6
X1	1	0.599**	0.764**	0.522**	−0.139	−0.095
X2		1	0.564**	0.391*	−0.02	0.053
X3			1	0.510**	0.361	−0.108
X4				1	−0.009	−0.311
X5					1	0.302
X6						1

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

9 Conclusion

Deviating from the normal path of geographical research on intra-urban inequality, the present study includes subjective components of livability. Inclusion of subjective dimension is considered necessary because it has been observed that the changing urban landscape-a manifestation of the interaction between culture and landform could not be evaluated adequately by objective indicators alone.

With respect to objective dimensions of livability, centrally located neighbourhoods are more livable than their peripheral counterparts. Neighbourhoods nearer to the Central Business District (CBD) have scored relatively higher indices of livability in almost every objective dimensions. Surprisingly, certain neighbourhoods which are located very near to the CBD do not rank high in every objective dimensions except accessibility dimension. The main reason behind the difference between these centrally located, low ranking neighbourhoods and the centrally located, high ranking neighbourhood is that the whereas the former are located at the more difficult steeply sloping surface on the eastern part of the city, the latter are located at the relatively flat area along the crest of the hill. Moreover, the main and busiest road of the city runs through the latter neighbourhoods along the crest of the hill where as the former neighbourhoods are connected by smaller roads. Thus, land values are relatively cheaper at the former neighbourhoods and relatively poorer people settled there. On the other hand, the latter neighbourhoods constitute the commercial hub of the city and land values are relatively higher.

Subjective dimensions of livability show different pattern with respect to objective dimensions. Location of neighbourhoods does not seem to have any relationship with level of satisfaction of neighbourhoods' residents on livability dimensions since no definite location-based pattern is observed. In the socio-economic environment dimension, middle layer neighbourhoods are ranked relatively higher than their peripheral and centrally located counterparts. On the other hand, satisfaction from physical and infrastructural dimension does not show definite pattern and interpretation of the result do not provide any significant conclusion. However, it may be interesting to point out that some peripheral neighbourhoods are ranked higher than centrally located neighbourhoods in both of the two subjective dimensions. This may be explained by higher levels of satisfaction in subjective variables like satisfaction from cost of living in own neighbourhood (S_COST), satisfaction from participation in community activities within neighbourhood (S_PARTICIPATION) and satisfaction from intimacy with neighbours (S_NEIGHBOURS). It is not surprising to find higher levels of satisfaction in these variables since these neighbourhoods are inhabited by relatively poorer people who are believed to have more attachment to traditional social values like neighbourhood unity and community works. It may also reflect the limitations of subjective measurement of livability that responses may vary depending on the respondents' level of knowledge, integrity and aspirations.

It is also found out that objective dimensions are positively correlated to each other and subjective dimensions are also correlated to each other. On the other hand, there is no significant relationship between objective and subjective dimensions.

It may therefore be concluded that location has significant importance in the pattern of livability but some neighbourhoods could not translate their locational advantages which may be due to unsuitable topographies and inadequate infrastructures resulting in different levels of livability within a few distances.

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