

CASE STUDY AN APPROACH TO MEASURE LIVABILITY OF SLUMS IN HILL SLOPE AREAS

Ramesh Srikonda & Srinivas Daketi – 2019



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ABSTRACT

Slums are growing and expanding at an alarming rate, and this needs more attention. The inability of city authorities to plan effectively as well as to enforce urban planning and land laws have given rise to the haphazard development of settlements and slum proliferation. Sustainable development, being a major component of urban planning, calls on planners to view slums as an aspect of urban development. The study establishes the factors that have led people to settle in the slums and goes further to identify the nature and status of the existing infrastructure. The opportunities and challenges facing infrastructure provision are highlighted with the aim of setting up a sustainable infrastructural planning framework that would create better living conditions. The study intends to develop a framework for analyzing livability at the scale of a slum neighborhood by seeking to understand the effects of certain identified physical and social aspects on livability.

The study examined the concepts of quality of life and subjective well-being which are explicitly different to livability but are used interchangeably with livability. Two slums in Vijayawada City, located in the state of Andhra Pradesh, India, were selected as the study area due to their vulnerable characteristics on hillslope areas, for which a livability index was calculated.

The first part of the study dealt with identifying the parameters based on which the livability of the neighborhoods can be judged. This was based on key informant surveys, certain contextual characteristics and understanding the theoretical parameters used in different livability studies.

Aspects including safety, mobility, social development and physical infrastructure needs were identified. Several research instruments were used, including household questionnaires, interview schedules with key informants, observation schedules enhanced by the use of photography, and a document analysis guide. Spatial stratified sampling and a systematic random sampling approach were adopted to identify the households. The analyzed data is then summarized in frequencies and percentages and presented in tables, bar charts and figures.

The second part of the study involved collecting detailed spatial and attribute data related to these parameters at the neighborhood level within a slum, using mixed method methodology (quantitative and qualitative). Several data collection tools were used depending on the parameter and the nature of the intended analysis. Each parameter was analyzed with the help of certain variables and standardized through a scoring logic based on the Likert scale.

The scores were aggregated using user-defined comparative weightages to arrive at a composite neighborhood level livability index. Furthermore, this composite index for all neighborhoods within the slum was used to calculate the integrated composite index for the slum. ARCGIS was used to carry out a spatial analysis, providing an interface between spatial and non-spatial data, which ultimately helped the production of this study.

The study could be significant to development agencies for comparing and assessing slums within a city with regard to their respective physical aspects when considering immediate intervention. ♦

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PART 1 INTRODUCTION

Livability is a concept of huge importance in the present scenario due to the increasing urban population (urbanization increased from 28% (Census of India, 2001) to 31% (Census of India, 2011). The reasons for migration can be to get better standards of living or opportunities, thus making the cities severely stressed in terms of the provision of their resources. Also, with their improvised economic status, people in cities expect more than just basic facilities, i.e. facilities which assist their social development and intercommunication. Abraham Maslow's hierarchy of needs states that after satisfying their basic needs, humans have psychological needs, like love, for which social interaction is quite important.

Hence the concept of livability. This stands for the creation of such an ideal ecosystem, in which all people achieve a decent or moderately high standard of living by having access to basic amenities. In addition, it is supported by appropriate infrastructure, a safe living environment and a good socio-economic, natural environment with law & order in place. (Kapoor. A, Garg. A (2012) Livability Index p. 7)

Until now, livability has been analyzed at global level, national level; however, livability at a local (neighborhood) level helps in understanding the disparity in livability within the city and gives an idea regarding the aspect in which work needs to be done so as to improve livability of an area within the city. Analysis of livability for a neighborhood can be done by simply understanding the scenario in the area (positive and negative aspects which affect the livability of that area), however if quan-

tified it gives a clear idea as to how livable the area is. The best way to quantify livability is by giving all the areas a score based on the area's scenario. The score given must be based on a common scale so that the different areas in city can be compared. Hence an index needs to be calculated, called a livability index, which takes a holistic approach to assessing the different neighborhoods within a city using several parameters, so that the strengths and weaknesses of individual neighborhoods can be assessed.

Need for study

As reported in the Livability Index, The Best Cities in India (2011, pg. 2), "Livability refers to an urban system that contributes to the physical, social, mental and personal development of all its inhabitants. It is about delightful and desirable urban spaces that offer and reflect cultural and sacred enrichment." Livability when seen at a slum level may be understood via various physical planning and social aspects which affect the livability in an area. Therefore, the study focuses on developing a framework for analyzing livability at a slum level which includes a selection of parameters which define livability and their analysis.

These aspects can be assessed through quantitative and qualitative considerations. However, the general trend is to only take the quantitative aspects into account while ignoring the qualitative ones. But taking qualitative aspects into account gives a clearer picture of the livability of an area. An example of both is given below:

Quantitative Aspect: Accessibility to nearest public transport stop is an important quantitative aspect when considering livability, indicating the connectivity and isolation of the area. However, the social implication of the same is a safe access to the stop, which is a qualitative aspect.

Qualitative aspect: Safety is a qualitative aspect which has a direct relation to the provision of lighting, as a well-lit street is safer than a dark street. The road width also directly affects safety. Accessibility to public conveniences, safe drinking water, open spaces and transportation are factors needed to assess sustainable living.

Expected outcome

The study would help in understanding the framework to analyze livability, in the form of selecting parameters that need to be taken into account while calculating the Livability Index and understanding the judgment criteria for each, based on the Likert scale. Also, the study would help in understanding the linkages amongst various parameters under different themes. The end outcome would be the framework which includes a palette of parameters which help in judging the livability of an area and the scoring logic which helps in quantifying the parameters so as to calculate the Livability Index. ♦

PART 2 LITERATURE STUDY

The literature study was done in three steps: the first being understanding the concepts related to livability; the second being analyzing the parameters used to calculate livability at different levels (global, national and local) and the third being understanding the methodology behind the calculation of different indexes.

The term “Livability” means an area which is ‘fit or suitable to live in or with.’ Livability has been defined at various levels, i.e. at a city level, at a neighborhoods level, and also within a country and at an international level. There have been many different definitions of livability, giving different insights into the concept of livability. Livability refers to an urban system that contributes to the physical, social, mental and personal development of all its inhabitants. It is about delightful and desirable urban spaces that offer and reflect cultural and sacred enrichment (Kapoor. A, Garg.A (2012) Livability Index p.7). According to the Victorian Competition and Efficiency Commission (2008), livability is defined as the well-being of a community and represents the characteristics that make a place people want to live in, now and in the future. Also, as per the United Kingdom department of communities and local government, livability is concerned with the quality of space and built environment. It is about how easy a place is to use and how safe it feels. Hence an area is called livable where people wish to live now and continue living in future because adequate amenities are provided, and a pleasant built and natural environment makes it desirable for living.

Community participation must be regarded as an act of involvement for the purpose of influencing

decisions about inclusivity in a healthy living environment. In addition to better decision-making, the other role of participation is upholding the principles of fairness and equity, the right of citizens to be informed and to contribute their views on governmental policies and decisions, the need to represent the opinions and views of disadvantaged and powerless groups and the need to capture the insights of citizens (Burby, 2003 and Baker, Addams and Davis, 2005: 490). As one moves up in the scale, from a community to a city to a region, the magnitude and consequent structures, complexity and power asymmetries and resources needed to undertake participation change significantly to establish the concept of livability (Pickering and Minnery, 2012: 250).

Quality of life is often referred to as general well-being of individuals and society (Englewood, 2011). The perspective of quality of life varies from person to person. The concepts related to quality of life include “happiness, subjective wellbeing, life satisfaction, the good life, the good society, economic wellbeing, family well-being, quality of work life, community quality of life, spiritual well-being, leisure wellbeing, social well-being, psychological wellbeing, emotional well-being and quality of home life among others. The quality of life on a whole deals with the physical, social and economic environment within the scope of individual needs.

Furthermore, according to the National Research Council 2002, livability is defined as ‘the attributes of a community that affect its suitability for human living’ whereas quality of life is defined as the effect of a community’s livability on its residents’. Therefore,

the quality of life is a subset of livability which just measures one dimension: the desires of the people. This may be essential but not the same throughout society and based upon individual choices, which are related to the presence and quality of the amenities of built and natural environments. Quality of life is the user experience of those amenities.

Subjective wellbeing has been expressed as a broad category of phenomena that covers people's emotional responses, domain satisfactions and global judgments of life satisfaction. (Diener, 1999). It also refers to how people experience the quality of their lives and includes both emotional reactions and cognitive judgments. (Diener, 1984). Livability, however, considers only the physical aspects of an area which might result in certain emotional reactions. For example, an accident occurring due to the lack of streetlights on the road might result in an emotional outburst, an outcome resulting from the lack of an appropriate physical aspect. Hence, 'livability of a person in an area' is what is called subjective wellbeing, in contrast to 'livability of an area for the people'.

2.1 Appreciation Indicators and Attributes

With regard to urban attributes and their related indicators for appreciation and managing cities (ADS, 2001), there are three different approaches to indicator construction being applied by different agencies:

- **Policy-related Approach:** This approach is used when indicators are developed as a result of government or community concerns in a particular area, and hence are closely related to the process of establishing urban strategies and policies. They work by developing a comprehensive inventory of major social goals or norms, and then devising indicators to measure these goals. This approach is used in the United Nations Centre for Human Settlements (UNCHS) indicators program.
- **Thematic/index Approach:** This approach works by establishing broad themes or concepts rather

than specific policy goals and is not necessarily directly associated with strategy. Such themes are multi-dimensional and involve different aspects.

- **Systems-based approach:** This approach is used by the Organization for Economic Development and Co-operation (OECD) to support environmentally sustainable agendas. This approach involves checking the sustainability of a physical system of an area. The pressure —state- response framework by the OECD is an example of the systems-based approach.
- **Performance-based approach:** This approach is used for checking the performance of an agency, and mostly used by local governments to measure the performance of different departments.
- **Need-based allocation approach:** This approach is used when indicators for the allocation of resources are defined based on the needs.
- **Benchmarking approach:** This approach is used as a method for organizations to improve their performance in key areas of practice. The process involves locating those areas needing improvement, deciding on indicators to measure performance, finding other organizations that have better performance on these indicators, and adopting or adapting the practices of these organizations that lead to better results.

Given below is a table, explaining the indicator frameworks for the six approaches:

Table 1

Indicator frameworks for the six approaches

FRAMEWORK	FOR WHOM	PURPOSE	SCOPE	CONTEXT	BY WHOM	EXAMPLE
Policy Driven	City planners, Policymakers	Dialogue between policymakers and stakeholders	City or sector	Political, pluralist	Stakeholders, experts	UNCHS
Theme or Index driven	Development professionals	Comparative	Theme or			
Metaphor	Development	Experts	UNDP			
Systems	Experts advising policy	Sustainability	City or theme	Physical	Experts	State of the Environment
Performance	Policymakers	Accountability	Sector	Budget-Setting	Bureaucracy	Program Budgeting
Need-based allocation	Central					
Policymakers	Resources for Target groups	Target				
Groups	Resource					
Allocation Setting	Bureaucracy	Asian				
Crises Thailand						
Benchmarking	Middle management	Efficiency	Organization	Units	Employees	Benchmarking

2.2 Livability principles

Partnership for Sustainable Communities, 2009

Partnership for Sustainable Communities was formed in 2009 by the U.S. Department of Housing and Urban Development, and the U. S. Department of Transportation and Environment Protection Agency (EPA) which also emphasizes livability and provides six principles of livability to improve access to affordable housing, reduce transportation costs, encourage multi-modal transportation, and protect the environment with development.

The six principles are given below:

- Provide more transportation choices such as the development of safety, reliability, improved air quality, less greenhouse gas emissions, sound economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, and promote public health.
- Promoting equitable and affordable housing to expand location and energy efficient housing, choices for people of all ages, incomes, races, and ethnicities to increase mobility and lower the combined cost of housing and transportation.
- Enhance economic competitiveness to improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers, as well expanding business access to markets.
- Support existing slum communities with federal funding through strategies like transit-oriented, mixed-use development, land recycling to increase community revitalization, and the efficiency of public works investments and to safeguard rural landscapes.
- Coordinate and leverage federal policies and investment. Align federal policies and funding to

Source: Compiled by author

remove barriers to collaboration, leverage funding, and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy.

- Value communities and neighborhoods. Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods—rural, urban, or suburban.
- From the above principles we can conclude that livability majorly deals with accessibility to basic and essential services or amenities in an area. Apart from this, it involves accessibility to transportation, environment protection, interaction amongst people living in the area, access to schools and hospitals for social development and also access to nearby markets.

The case studies were conducted in 3 different scales in order to observe the changes in indicators with changes in the theme of the study.

2.3 Spatial Considerations

Livability is the main criteria for ranking the best cities. The EIA conducted a survey to identify the best cities, based on livability, or a Livability Index, and organized a competition to combine data from worldwide cost of living and livability surveys from other sources, to provide a ranking of its own.

The initial assessment for ranking carried out by the EIU was based upon five indicators: Political and Social Stability, Health Care, Culture and Environment, Education and Infrastructure. The selected indicators mainly reflect levels of social development, ignoring aspects that indicate the quality of space, which directly affects livability.

Therefore, out of the total no. of entries, the winning entry was the one which included a new dimension in the concept of calculating Livability: the inclusion of spatial characteristics as the sixth indicator. The spatial characteristics reflect the following aspects of city life: urban form (sprawl, green space), the geographical situation of the city (natural assets,

isolation and connectivity), cultural assets and pollution. The new livability index became known as the Spatially Adjusted Livability Index.

The spatial aspects included two major components:

A. Urban form

Green Space: A green space improves the livability of the city. The green spaces were measured on the basis of 3 aspects: the distribution of green spaces within the metropolitan region, the number of local green spaces and the number of metropolitan-scale green spaces.

Urban sprawl: sprawl or excessive spreading out has a negative impact on livability as it decreases livability, encourages private transport usage and increases cost of public transport, thereby degrading the quality of the environment.

B. Geospatial conditions of the city

Natural Assets: Access to nature is an important indicator for a city's livability. Therefore, all the natural features within a 100 km radius from the city center were taken into account. The surface area of all protected areas within a 75km radius from the city center was also considered in the ranking.

Isolation: Isolation of a city negatively affects the livability of the residents of the city as it reduces the possibility to explore surroundings. Therefore, all the large cities within a 200km radius and their populations were considered while ranking.

Connectivity: Livability increases with the ease of reaching that place. Therefore, for the connectivity all the flights leaving the city and coming to the city were considered while ranking.

Cultural Assets: The availability of world class cultural assets improves the livability of a city. All the world heritage sites within the vicinity of city were considered while ranking.

Pollution: Pollution directly affects health and is an integral element in calculating the livability of a city. The indicator selected was the concentration of particulate matter of over 10 micrometers (PM10) in the air. In practical terms, while calculating livability, the weightage of the initial five categories was reduced to 75% and the newly added sixth category, spatial characteristics, was given 25% weight. This was a more appropriate weightage as all the initial five indicators rely on space to reflect social development and therefore spatial characteristics were given prime importance.

The spatial characteristics indicator brought changes in the ranking of cities. Hong Kong, having an initial ranking of 10, moved up to rank 1 due to its green spaces, controlled urban sprawl, large no. of natural assets in and around the city. Also, the city has many large cities within a 200 km radius which gave it a high ranking in the aspect of isolation. Toronto, on the other hand, moved down by 7 ranks to 8th position from 1st due to it getting low scores in urban sprawl, natural assets, cultural assets and isolation from other cities.

2.4. Livability Index for Cities

When studying livability in a particular country, the context plays a key role as many indicators which are context-specific come into play. The Livability Index helps in understanding the living potential of different cities in India. They give a clear picture of the strengths and weakness of a particular city and also of the country as a whole.

The parameters selected give a view of the quality of living conditions in different Indian cities. The indicators adopted for quantifying livability is an adaptation of the world-renowned diamond model of Prof. Michael Porter of the Harvard University. A livable city can be defined as one which directly benefits the people living in it as well as the people visiting it.

Livability is a relatively new concept in India when compared to other, more highly developed countries. India is a developing economy and hence the standards of living definitely differ from other countries. Therefore, the indicators to be applied are contextual and differ from those applied in other countries to quantify livability.

The basis for selecting indicators was defined when we decided on the theme of this study. Here the study was conducted to analyze and compare the living conditions of cities across the country. Livability was affected not just by a single component but a group of heterogeneous indicators, the combination of which defined the overall livability of a city. Indicators under the above-mentioned pillars were selected which help to detail out livability.

The indicators used under the different pillars are:

- **Demographic:** Population, migration, labor participation.
- **Education:** Education level, Occupation Level.
- **Health and Medical standards:** health indicators, health support infrastructure.
- **Safety:** crime, road accidents.
- **Housing options:** housing cost and availability, urban household crowding.
- **Socio-cultural-natural environment:** Supporting infrastructure, natural environment, and cultural environment.
- **Economic environment:** Income and environment, economic infrastructure, business environment, purchasing power.

All the different indicators were evaluated and given a score, the different pillars and indicators considered within them were ranked and finally, an index was calculated.

On comparing the international study of Best Cities ranking and the report by the Economic Intelligence Unit (EIU), it was found that the type of indicators

changes when studied at an in-country level as key issues in the country are taken up to evaluate within the country. Whereas at a global level only those indicators can be taken up which are common to all the countries. Education within a developing country like India is a key issue, whereas in developed countries the key issue isn't education but might be their high levels of industrialization.

2.5 Local Area Studies

Key Indicators for Melbourne Neighborhoods (Lowe .M, Whitman .C, Badland.H, Davern.M, Hes. D, Aye. L, and Butterworth, Giles-Corti B, 2013) are shown in the list of subjective and objective indicators which fit within the 11 different themes below:

- Crime and Safety
- Housing
- Education
- Employment and Income
- Health and social services
- Transport
- Public Open Space
- Social Cohesion and Local Democracy
- Leisure and Culture
- Food and other local goods

2.6 Cairns city council livability study

Cairns City Council (2006) did a study on the livability of the city and to measure the council's strategic plan. The indicators used were:

- Affordability
- Accessibility
- Mobility
- Diversity
- Equity
- Amenity
- Well-being
- Good leadership

The results of the study have led to considerable improvement in terms of accessibility to public spaces and other facilities, and limited improvement in other areas.

2.6.1. Australian Unity and well-being Index

In 2001, Australian Unity, in partnership with the Australian Centre on Quality of Life at Deakin University, calculated Australian Unity and well-being Index for the first time, in order to capture the impact of factors which affect society and are not included in economic measures such as Gross Domestic Product.

The index has two components: personal and national well-being. Personal well-being is measured using the following factors:

- Standard of Living
- Health
- Safety
- Personal relationships
- Community Inclusion
- Life Achievements
- Social Conditions
- Environment
- Governance

2.6.2 National well-being is measured using the following factors

- Average satisfaction with social conditions.
- Economic situation
- Environment
- Governance
- Business
- National security

2.6.3 HDI Mumbai

The Human Development Report, Mumbai was prepared in 2009 and was the first HDR at municipal level in the world. The report studied the condition of the city at slum level in terms of livelihood, job opportunities and basic urban services such as water supply, sanitation, education and health.

The main indicators were detailed out meticulously to reveal the condition of the city's basic services and social development factors at slum level. The indicators considered were:

- Population trends - density, FSI, migration
- Education
 - Literacy levels: population growth, accessibility to schools, quality of schools
 - Access to education: nearness to primary school, schools for different age groups, teacher –student ratio, accessibility to schools based on income levels, school and class environment, safe access to schools, anganwadis and balwadis, enrolment of students (per school)
 - Slum: school type (govt., private), teachers, boys, girls, playgrounds, safe access.
 - Gender-specific schools: school dropouts, anganwadis.
 - School for children with special needs
 - Informal sector: per capita income
 - Slums: no. of households, accessibility to water supply, quality of water supply, demand and supply gap in water supply, access to toilets.
 - Health: accessibility to PHC, manpower, diagnostic and therapeutic services, no. of dispensaries, no. of pediatricians; accessibility to private doctors, municipal hospitals, private hospitals. Quality of life, health behavior, work environment, emotional element, access to basic necessities, social interaction, sense of security.
 - Commuting: modes of transportation, bus service
 - Pollution: air quality, noise levels, solid waste management, storm water drainage network
 - Recreational facilities

The HDR is calculated against the given indicators. The indicators were detailed out very precisely and also care was taken to understand the correlation amongst different indicators.

2.7 Methodology for appreciation of index

2.7.1. Human Development Index

The Human Development Index was developed in 1990 and measures human development in terms of the formation of human capabilities such as improving health, increasing knowledge and skills to meet human needs, their own skills and competence, leisure time, job security, cultural, social and political events. (Ingrid Majerova, 2012). The methodology developed initially was followed from 2009 to 2010; a significant change in the index calculation came about when the inequality-adjusted HDI (IHDI) was introduced, which measures the level of human development in a society that accounts for inequality. When there is perfect equality, the IHDI is equal to the HDI, but it falls below the HDI when inequality rises. Hence, the IHDI is the actual level of human development (taking into account inequality), while the HDI is an index of the potential human development that could be achieved if there is no inequality. The IHDI takes into account the inequality in HDI dimensions by “discounting” each dimension’s average value according to its level of inequality measured by the Atkinson Index (Ingrid Majerova, 2012).

For this reason, both the methodologies are explained below:

2.7.2 Human Development Index process

The three components that were used to calculate HDI till 2009 were life expectancy, knowledge and living standards. Knowledge was further subdivided into two parts: literacy in the adult population and a combined share of enrolled students. Living standards was expressed through GDP. Each dimension was represented by an Index, i.e. life expectancy index, education index and standard of living index expressed through GDP. To determine the indices, two types of formulas were used. To calculate the life expectancy index and education index, the formula used was:

[1]

$$H\text{Stand} = (H_s - H_{\min}) / (H_{\max} - H_{\min})$$

Where, Hstand — standardized value,

Hs — real value,

Hmin — minimum value,

Hmax — maximum value

To calculate the living index, the formula used was:

[2]

$$H\text{Log} = (\log H_s - \log H_{\min}) / (\log H_{\max} - \log H_{\min})$$

Where, Hlog — logarithmic value,

Hs —real value,

Hmin — minimum value,

Hmax — maximum value,

The Hmax and Hmin for all three dimensions are standardized values, calculated based on the data for every year. The calculated three indices (life expectancy index (LEI), education index (EI) and GDP index) are then used to calculate overall HDI, using a simple arithmetic average, as shown below:

[3]

$$HDI = (LEI \times EI \times GDP) / 3$$

Where, LEI— life expectancy index,

EI — the index of education,

GDP Index — living index

2.7.3 Inequality-adjusted Human Development Index

The calculation dimension of two out of three indices were changed (health indicator index is the only one which remained unchanged). The literacy rate of the population was replaced by the expected years of schooling; the combined gross enrollment by the average number of years of education (knowledge dimension) and dimensions of living standards is now measured by GNI per capita in purchasing power parity to the USD. The minimum (Hmin) and maximum (Hmax) values used to calculate Hstand and H109 (formula as given above) were determined for the minimum and maximum values of each dimension based on the monitoring for the particu-

lar year, but in different proportions than before. However, from 2010 onwards the minimum (Hmin) values were set so that their human development level values were not possible, and the maximum values corresponded to the specific values obtained in some economies (Ingrid Majerova, 2012). The overall index was previously calculated by a simple arithmetic average of all indices, but this method allowed for substitution between different indices i.e. low values in one dimension can be compensated by high values from another dimension. Since 2010, the calculation of the overall index has been done using the geometric mean, which eliminated the scope of substitution (as happened in the previous method).

2.7.4 New Zealand Apartment Living: Developing a Livability Evaluation Index (NZALI) The methodology used to develop the New Zealand Apartment Living Index was:

- Framework development of NZ ALI,
- Use of ranking method in obtaining weights to be applied to components of NZ ALI index,
- Consultation with end users to ensure that NZ ALI fulfills all criteria and is fit for purpose.

Under the first part, i.e. the framework development, the first step was to identify factors based on literature study which were considered important regarding livability in New Zealand apartments. These factors were grouped into different categories and sections as part of the literature review. Step one of the framework development required each of the identified factors be assessed for two reasons:

- To remove any repetition between the initially identified factors,
- Compliance with above criteria, relevant to livability.

A hierarchical structure of factors affecting livability of apartments was already present, with categories and sections being the 2nd and 3rd levels of hierarchy. The main objective, livability in New

Zealand apartments, was the top level of hierarchy. Furthermore, the factors grouped beneath the section were regrouped, which became the 4th level of hierarchy. Aspects regarding each level of factors were identified which became the fifth level of hierarchy. Indicators of each aspect were then identified to become the fifth level of the hierarchy. Indicators outlined how each aspect would be assessed. Each of the selected indicators was considered an 'Assessment Question'. Each of these required an Assessment Method [AM] so that all components of the tool were appropriately considered by users.

Assessment methods initially identified for the indicators were then reviewed against practicality and objectivity. Any that did not meet the requirements were reworked. None of the indicators were removed to ensure that a complete livability evaluation could be performed.

The final step in developing the framework was to determine how credits would be assigned to each of the indicators, depending on the user's answer. Credits were assigned based on the acceptability of the answer:

- Each indicator could provide up to 100% of its weighting (weighting to be determined during the Index Calibration stage of the research),
- Once weightings were determined, these credits could be applied so that NZ ALI was a functioning evaluation tool
- Depending on the assessment method and answer type, a credit-giving mechanism was developed (scoring logic), where credit was assumed anywhere between 0-100% for each type of indicator.

The second stage in the development of NZ ALI was calibration of components within the tool. To obtain the weightages for each of the NZ ALI components, a questionnaire was used to survey different groups of people who had experience and knowledge of New Zealand apartments to determine what they consider to be important in relation to livability.

The results from the survey provided the basis for assigning the weightages to be applied to the NZ ALI components. Questionnaire respondents were required to either nominate components they considered to be the most important (at aspect level) or rank components in order of importance (at feature, section and category level) in regards to apartment livability.

Each set of components was assigned a total of 100% (i.e. each set of aspects under a feature, each set of features under a section).

The weightage for aspects was determined based on how important the survey respondents believed them to be. Participants were asked to nominate one aspect they considered to be most important. For the weightages to be assigned for features, sections and categories, the survey respondents were asked to rank each component, with one being the least important.

Using the data collected, the different apartments were given a credit for all the indicators (based on credit giving mechanism), and finally, using the weightages and credits, the final index was calculated.

The final step in the development of the NZALI was index validation. This was done by testing NZA LI functions on four apartments and evaluating the results compared to the interviews with apartment occupants regarding how the apartment had affected their livability.

- a. Livability differs from quality of life and subjective well-being as the latter two deal with individual needs.
- b. Livability indicators change with changes in the scale of study.
- c. As the scale of the study zooms in, the magnitude of detailing in the indicators increases.
- d. Livability is a subset of quality of life, as quality of life includes physical, economic and social parameters and livability only deals with physical aspects.

- e. Livability and subjective well-being bear a contrasting relationship with each other as in livability the subject is area and in subjective wellbeing the subject is the person.

A livable area is one that is safe; attractive; socially cohesive and inclusive and environmentally sustainable; with access to education, public open spaces, local shops, health and community services and leisure and culture opportunities, via a convenient public transport, walking and cycling infrastructure.

- a. For the development of a framework to calculate the index:
- b. The first step is to identify the indicators which will be used to calculate the index
- c. The second being norming the indicators so that all of them are brought to a common scale.
- d. Third is assigning weightages to indicators. The final step is the calculation of the index.

2.8 Themes of Livability

2.8.1 Based on literature study we concluded that livability for an area is based on the following aspects:

- Transportation Choices (Livability Principles: Partnership for sustainable communities, 2009)
- Energy efficient housing choices (Livability Principles Partnership for sustainable communities, 2009).
- Access to employment centers. Education centers (Livability Principles Partnership for sustainable communities, 2009)

- Safety (livable, healthy, sustainable: What are the key indicators for the Melbourne neighborhood?)
- Education (livable, healthy, sustainable: What are the key indicators for the Melbourne neighborhood?)
- Health (Australian Unity and well-being Index)
- Open spaces (livable, healthy, sustainable: What are the key indicators for the Melbourne neighborhood?)
- Social Cohesion (livable, healthy, sustainable: What are the key indicators for the Melbourne neighborhood?)
- Mobility (livable, healthy, sustainable: What are the key indicators for the Melbourne neighborhood?)
- Governance (Australian Unity and well-being Index)

All the above parameters were selected from literature study, keeping in mind that accessibility to the physical amenities affects livability.

Also, as part of the primary survey, a key informant survey was carried out in order to bring in the aspect of people's participation. The respondents were people from different age groups; school children, youth, working class, housewives and old people). The responses people gave for each question were grouped under different aspects defined through literature study (as above) and are given below alongside the question. ♦

PART 3

METHODOLOGICAL FRAMEWORK

The understanding and measure of livability in urban areas is predominately related to the physical planning attributes and social development aspects within a territory. The aim is to develop a framework for quantifying livability and to create a platform for assessing the similarities and differences amongst the residential neighborhoods.

Objectives

- I. To identify the themes defining livability and the parameters related to each of the themes as above at slum level within a city.
- II. To study each of the parameters individually and compare them between the two slums.
- III. To analyze each of the variables related to the various parameters at a neighborhood level within the slum and calculate a composite livability index for all the neighborhoods within the slum.
- IV. To calculate the integrated composite livability index for the selected slums by aggregating the neighborhoods' livability index within the slum. ♦

PART 4

PROCESS AND ASSESSMENT

On the basis of said methodology, the objective of the study is to understand the present condition of the existing settlements in order to assess their livability. The data collected form the secondary and primary sources. The pertinent, firsthand information was considered and assessed by means of household, stakeholder and observation surveys. The salient features of the same is given below:

4.1 Secondary Data

The data collected from various government sources are:

- Slum data census 2011
- Slum Map
- Staircase Map
- Solid waste collection
- Water supply
- Sanitation
- Underground drainage

4.2 Primary Data

The data collected is from household questionnaires, surveys, key format surveys and also from observation surveys.

- Type of water supply, water quality and frequency
- Cleanliness within slum (drains, staircases, roads, solid waste dumping)
- Type of toilets
- Type of sewerage system
- Safety within slum

Other data collected from the primary survey are via observation survey

- Plot-wise land use
- Right of way design
- Location of streetlights
- Unauthorized dumping sites
- Socio-economic status of residents

4.3 Data Collection Methods

- Household Survey – This method is used to collect data from the household. The method is similar to Systematically Random Sampling by grouping the neighborhood
- Stakeholder survey – This method is used to understand the people's view of their livability.
- Observation survey – This method is used to understand the various aspects affecting livability by observing the lifestyle patterns of local residents in the slum
- Urban areas being “Engines of Growth” act as economic and employment generators of a state or a country. These urban areas are facing obstacles to their growth because of haphazard development. Growth of an urban area takes place due to an ever-increasing population, which can be through natural growth and migration. Migration to urban areas might be because of various push and pull factors between rural areas or other urban areas. The migrant population in particular is spread haphazardly all over the urban area, as their livelihoods occupy open spaces and vacant lands. This unplanned growth results in various problems relating to economy, provision of infrastructure and other developments of the urban area. It becomes difficult for city development and administration authorities to avoid such hindrances in the harmonious growth of the city. In order to mitigate the severity of the problems attendant to such unplanned and fast development, and to ensure the overall well-being of the urban population, the local urban bodies and the local development authorities have initiated measures but the informal settlements of 100 and more already exist, so it has to be addressed critically as to how to bring them

in to the mainstream. It is equally essential and crucial to understand the habitable conditions of those areas or pockets.

4.4 City in History

Vijayawada is a flourishing town of great historic importance. It was one of the important cities early in the Christian era, and the religious centre for the kingdom of Vengi. Quite a number of antiquities found in and around Vijayawada confirm the city's ancient existence. The Epic of Mahabharata refers to the Indrakiladri hills as the place where Arjuna secured "Pasupathastra" from Lord Siva. This historical town originated on the northern bank of the river Krishna and, by 1855 AD, the town was in the form of a small settlement on the eastern side of the Indrakiladri hills.

The growth of the town picked up momentum after the construction of a barrage and three irrigation canals, namely the Eluru, Ryves and Bandar canals in 1855, and the rail bridge over the river Krishna in 1892. The city experienced a modest growth in the pre-independence era; however, after independence, the construction of road bridges over the river Krishna, establishment of the South-Central Railway terminal, setting up of divisional headquarters, major government offices including district court, major institutions for higher education, major commercial and distributive trading activities, wholesale establishments, agricultural marketing centre and Jawahar Auto Nagar Industrial Estate tremendously affected the city's growth.

4.5 City in Its Regional Setting

Vijayawada, the third largest city in the state of Andhra Pradesh after Hyderabad and Visakhapatnam, is also one of the important commercial and transport centres of the state. The city was the headquarters of the Taluk for a long time and acted as a central point for many of the districts of the state. Over the years the city has grown as a major economic, cultural and administrative nerve

centre of coastal Andhra due to its nodal location as an important railway junction and also because National Highway-5 and National Highway-9 traverse the city. The city also has a few places of historic importance.

4.6 Location

The city is situated at the foot of a low range hills on the northern bank of the river Krishna with its cardinal points as 16° 31' North latitude and 80° 37' East longitude, around 70 km away from the coast.

4.7 Land Lay and Topography

The land lay of Vijayawada is characterized by four canals, four hills and the holy river Krishna. Vijayawada, when approached from Guntur, welcomes with historic gates across the holy river Krishna. The way to Machilipatnam runs parallel to Budamerru canal and crosses two other canals. All these canals through the city obviously cause some hindrance to growth and traffic, but definitely look picturesque from a bird's-eye-view.

There are four major hills:

- Indrakiladri hill
- Orr's hill
- Disafforested hill and
- Moghalrajapuram hill

The natural slope of the old town falls from north to south whereas the new town slopes down from west to east. When compared to the old town, the new town is flat and hence makes drainage less effective. Though the city is protected from high flood banks on the southern side, the low-lying lands are not immune to floods, when the river Krishna is in full spate.

4.8 Soil Condition and Ground Water

Soil

Generally, black cotton soil - with exceptions in hilly areas - is dominant in the zone. The sub soil is moist clay which is good for agriculture. The urban area mainly constitutes three types of soils, namely

alluvial, black and red ferruginous. Fertile alluvial soils are available in the Krishna delta area whereas red ferruginous soils are spread over the uplands. In the Giripuram area, metamorphic rocks are found in the sub-soil strata.

Ground Water

Water can be tapped at varying depths from 3-5 m. Nearly one-third of the entire city's water supply is from ground water sources. The alluvial spread along the Krishna River and the canals also contains aquifers within shallow depths, which provide continuous support for cultivation activities in the entire region.

4.9 Climate and Rainfall

The climate of Vijayawada is tropical in nature with hot summers and moderate winters. The climate is hot and dry throughout the year. Summers are quite hot with very minor difference between the maximum and minimum temperatures. Vijayawada is located on the line which separates the delta-irrigated lands and, the dry uplands of the district. The climatic cycle can thus be divided into four seasons:

- Cool months January and February
- Hot months March to May
- Monsoon (S.W) June to September and
- Monsoon (N.E) October to December

Vijayawada and the surrounding areas experience high temperatures. The mean daily maximum temperature is 47°C, while minimum is 27.7°C in this region. The temperature begins to rise in mid February and May is the hottest month. December and January are usually the months with the lowest temperatures during the year. During these two months, the mean daily maximum temperature is about 29°C while minimum is about 19°C. The cold weather period in Vijayawada is normally during the rainy seasons. The city receives an average annual rainfall of 965 mm and the bulk of the rainfall is received during south-west monsoon period. The sky is generally overclouded during the southwest monsoon season. North-west monsoon breaks the hot spell and makes

the weather bearable. South-west monsoon follows thereafter and lasts until the end of September. October and November constitute the post-monsoon period. The period from December to mid-February is generally marked by fine weather. The rainfall in the region generally decreases from east to west. This region receives maximum rainfall both by southwest and retreating monsoons. Two thirds of the annual rainfall are recorded during southwest monsoon. During February to June, the relative humidity in the afternoons ranges from 68-80%.

Wind Direction

The direction of wind in the region around Vijayawada in the hottest months of April and May is from south to east in the morning hours and, in the evening from southeast to northeast. In the warm months from October to March, the wind blows in the morning from east and north and, in the evenings mostly from southeast and east.

4.10 Vegetation and Landscape

Vijayawada and its surrounding region is fairly rich in agricultural activity due to the Krishna River. The soil is also suitable for cultivation. Rice and sugar-cane are the principal crops cultivated in the region. Coconuts, guava and mango are the major tree crops found all over the Vijayawada region.

4.11 Growth of the City

The growth of the town during 1855 AD was along the banks of the river Krishna abutting the Indrakiladri hills, around the temple of Lord Malleswara. During 1905 AD, growth started along the canals and areas abutting the Indrakiladri and Gandhi hills. The city grew further along the three canals with more growth along the Bandar road. As the city grew further along the Eluru road towards the Gunadala hills, because of better infrastructure and transportation facilities, it absorbed many of the surrounding villages. The area of jurisdiction of the municipality increased from around 30 sq km in 1888 to around 58 sq km in 2004.

4.12 Administration Status and Governance

Vijayawada Municipality was set up in the year 1888 with an administrative area of around 30 sq km. The Municipality was upgraded to a selection grade in the 1960s and received Corporation status in the year 1981. The Vijayawada Municipal Corporation was spread out over an area of 29.4 sq km. The city Zonal Development Plan Area presently covers Bhavanipuram, Patamata, Payakapuram, Gunadala, Kundavari and Kandrika. As per the revenue records, the extent of the present municipal area is 61.88 sq km. The details of the areas included in the Vijayawada Municipal Corporation are given in Table 2.1. The governing body of the Corporation includes elected corporation council members headed by a Mayor for a period of 5 years. For administrative purposes, the Corporation area was earlier divided into 3 circles and 50 wards. Each ward of the Municipal Corporation is represented by an area corporator. General administration is under the control of the Commissioner of the Corporation who is assisted by an Assistant Commissioner, Superintending Engineer, City Planner, and Public Health Officer with a host of other officers.

Table 2

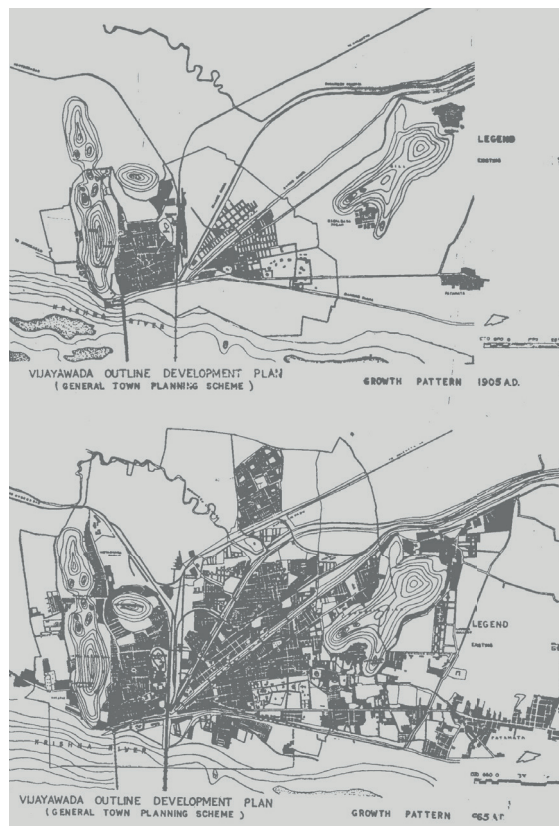
Total area of Vijayawada Municipal Corporation, 2001

S.NO.	SETTLEMENTS	EXTENT OF AREA (SQ KM)
1	Vijayawada (Urban)	30.0
Town Panchayats		
1	Gunadala	12.28
2	Patamata	7.98
3	Bhavanipuram	3.35
Sub Total		23.61
Village Panchayats		
1	Payakapuram	1.42
2	Kundavari Kandrika	1.17
3	Vijayawada (Rural)	5.68
Total		8.27
Grand Total		61.88

Source: VMC, and land Records.

Figure 1

Growth of the city from 1855 to 1965



AN APPROACH TO MEASURE LIVABILITY OF SLUMS IN HILL SLOPE AREAS

PART 4 – PROCESS AND ASSESSMENT

The location of informal settlements shown in Fig. no 2 and 3. To understand the condition, two locations were selected, i.e. Arul Nagar and Bethlaham nagar slum.

Figure 2
Arul Nagar slum

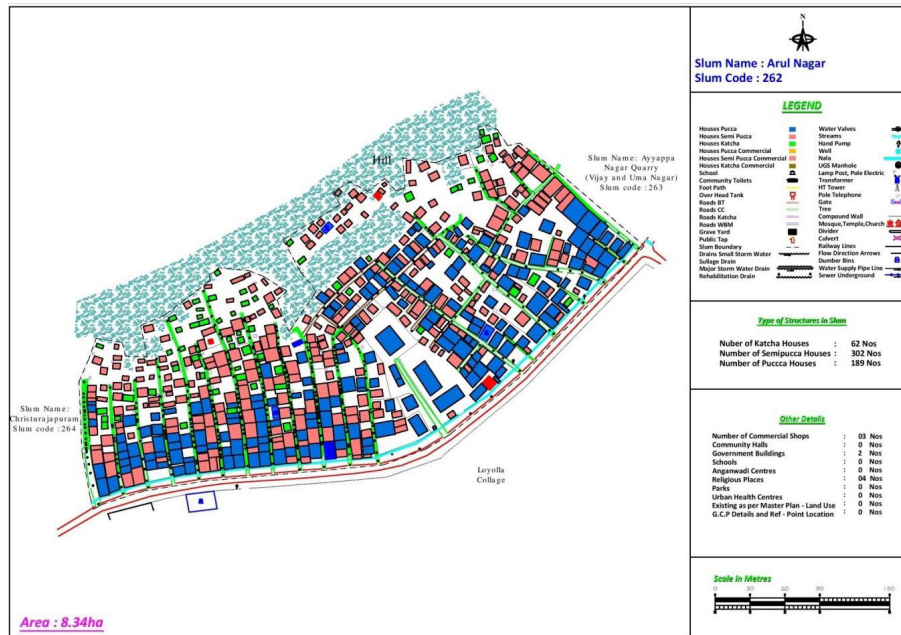
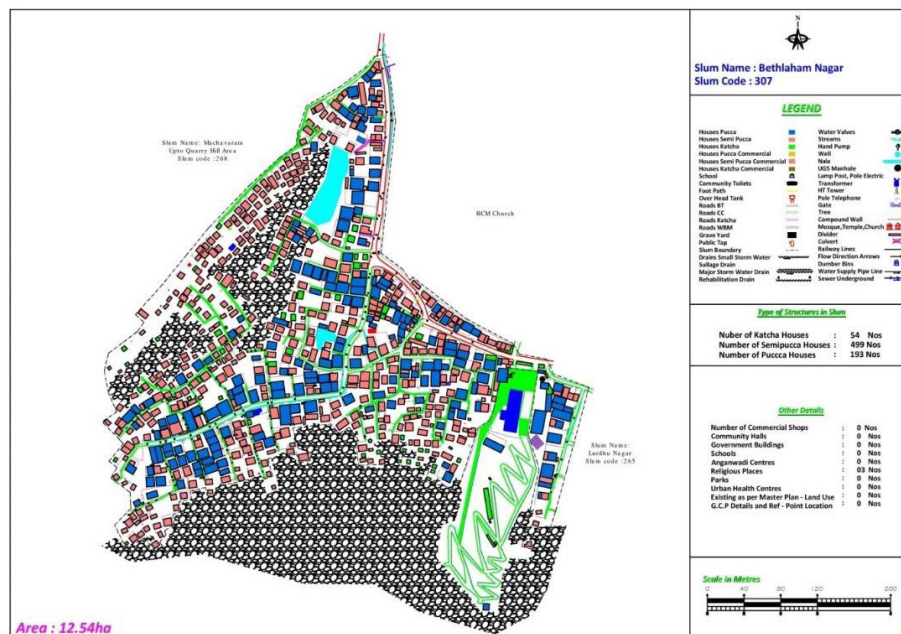


Figure 3
Bethlaham Nagar slum



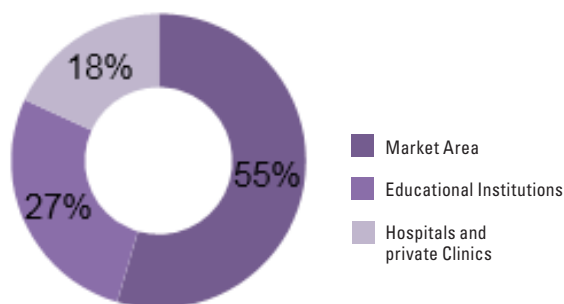
PART 5 ANALYSIS AND DISCUSSION

Features that support livability in Arul Nagar Slum

The responses to the questions in the questionnaire are given in the pie chart and the levels of supportive features in the Arul Nagar slum are as follows. These are the main aspects which are mandatory to make the slum comfortable.

40% of the people said that access to various facilities like the market area made their slum secure; safety is the other element, with 25% of the people saying the slum is livable. Good connections to the major junctions is also one of the aspects, with 35% saying this made their slum habitable.

Figure 4
Access to facilities



Access to facilities

As observed in Fig. 4, the majority (55%) of the people says that the nearby market area is the major feature that makes their slum livable. 27% said that educational institutes like Loyola College, consisting of both schools and coaching centers, are the second major aspect adding strength to their slum and making it livable. For 18%, nearby hospitals and private clinics like Ramesh hospital also make their slum livable.

Safety of Arul Nagar Slum

Supportive features consisting of safety concentrate on the safe living of the people in the slum. Most of the people say that there is very little theft in their slum (10%), active police in any case of emergency (80%), safety for women (70%) are major factors making their slum more livable. Proper streetlighting is the most important aspect to be considered, as the location is on the hills, where streetlights play a major role in providing safety for the people (90%).

Well-connected area

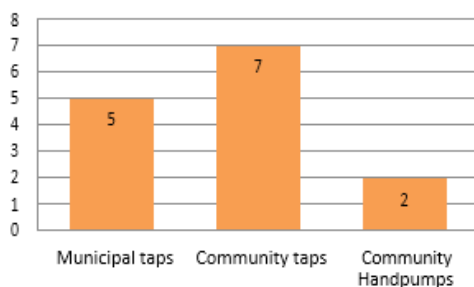
In the combined supportive features of the slum, 60% and 70% of the people respectively responded that availability of public transport and proximity to the railway station is the main supportive feature making their lives comfortable, as their income only supports public transport. A well-connected junction is only about 1 – 2 km away from the slum. People said that the types of public transport available to people are rickshaws, service autos and city buses which cost less than public transport. However, 50% of the respondents expressed satisfaction with the connectivity.

5.2 Deficient features of Arul Nagar slum which don't make it livable

These deficient features have been assessed to find out which major aspects don't make the slum livable. 42% stated improper roads as the major feature making the slum non-livable, due to lack of proper space. Dirty areas are the second important aspect making the slum non-livable according to about 29% of the respondents. Poor living conditions make the slum non-livable to about 17%. Poor water supply is another aspect making the slum non-livable with about 12% still without water supply connections or even community water taps.

Figure 5

Water facility type



Inadequate access

About 35% of the people complained about the poor condition of the staircases and the lack of roads to the hill slopes. These stairways were built very long ago and are not safe for children and old people which leads to accidents. 40% also expressed that excessive traffic on the foot hill roads are unsafe for children, as there is nowhere for people to park their rickshaws, two-wheelers, and three-wheelers on the roadside, which creates heavy traffic in the morning hours from around 7am–9am. Kiosks are not seen in the slum but only on the roadside, which creates disruption that increases the traffic in the area. Out of this, the poor condition of the staircases is the most deficient aspect making the slum non-livable.

Dirty area

Unhygienic conditions due to the dumping of solid waste on the top of the Hills makes the area unfit to live. 60% of the inhabitants are dissatisfied due to jammed sewers every rainy season. 40% responded that the dirty drains, and not cleaning the underground drainage pipelines until they overflow, are the most important factors making slum conditions unsuitable for living.

Poor Living Environment

The poor living environment aspect shown in Fig. 10 includes stray dogs on Hill slopes that make 8 out of 10 residents feel unsafe at night. Children are at risk of dog bites. Pollution due to solid waste com-

bustion is another aspect making the place unlivable because there is no garbage collection from hillslope dwellings. Loud noise from the quarrying activities in the Gunadala Hills is an additional aspect making the place unlivable.

Water connection type

The main aspect making the place unfit to live for about 50% of the inhabitants is the lack of municipal taps. While community taps are available, these are only for a limited number of users. There are only two community hand pumps at the foot of the hill, no hand pumps on hill slopes.

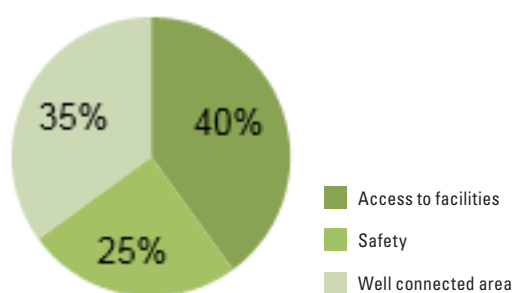
5.1 Features of Bethlaham Nagar slum that support livability

The responses to the qualitative analysis indicate the supportive features in the Bethlaham Nagar slum in Vijayawada, as shown in Fig. 6.

40% of the people responded that access to various facilities like the market area was in order and 25% were satisfied with the safety aspects. 35% expressed appreciation for the good connectivity of their habitation and hence that the locality was livable and safe. Good connections to the major traffic junctions was also one of the aspects which make Bethlaham slum livable.

Figure 6

Supportive features in the Bethlaham Nagar slum



Access to facilities

The survey reveals that the majority of the people (45%) says that the nearby market area is the major reason for staying in that area. Nearly 22% of the inhabitants said that educational institutes like Loyola College, consisting of both schools and coaching centers, are the second major aspect adding strength to their slum. Proximity to hospitals and private clinics like Ramesh hospital are also aspects that made them settle in this area and it appears that access to social infrastructure is quite adequate.

Safety

The survey indicates that according to the people, there is very little theft in their slum, adequate active policing in case of emergency, and safety for women, which are major factors making their slum more livable. Proper security lighting also exists, which was observed as a most important aspect to be considered as the location is on the Hillslopes, where streetlights play a major role in providing safety for the people.

Well-connected area

The study and analysis of integrated features of the slum is essential to assess the livability of the slum with regard to various features, connectivity being one of the most important parameters; the study indicates that 7 to 8 out of a scale of 10 showed that access to public transport and proximity to major roads and transport systems exist, and adequately satisfy the requirements.

5.2 Deficient features of Bethlaham Nagar slum which don't make it livable

The main reason making the slum uncomfortable is inadequate stairways to hillslopes, as 42% shows in Fig. 16. Dirty areas is the second most important aspect making the slum unhygienic, according to 29% of the inhabitants. 17% responded that poor living conditions make life difficult. Another aspect making the slum unlivable is the water supply type, with 12% of the population still not having water supply connections or even community water taps.

Inadequate access

About 35% of the people said that the condition of the stairways to hill slopes are poor and there are no roads yet to all hill slopes. Furthermore, these staircases were built very long ago and are unsafe for children and old people, which leads to many accidents. In addition, excessive traffic on the roads is unsafe for children, as people park their rickshaws, two-wheelers and three wheelers on the roadside, which creates traffic jams in the morning hours from around 7am-9am. Kiosks have moved out of the slum to the roadside, causing hazardous situations and increasing traffic in the area (40%). Thus, poor stairways, traffic conditions and unorganised parking make their lives miserable.

Dirty area

In the grouped aspects, unhygienic conditions are due to the dumping of solid waste on the top of the Hills, which makes the area unfit to live in. The second aspect is blocked sewers due to garbage in the area, causing problems in the rainy seasons. Respondents said the most important factor making slum conditions unsuitable for living is the dirty drains and the fact that the underground drainage pipelines are not cleaned until they overflow. Other aspects of deficiency are dumping of solid waste in non-permitted areas. The survey shows 100% dissatisfaction with solid waste dumps, and 80% responded negatively about the unhygienic conditions.

Poor living environment

Stray dogs on the hillslopes endanger the lives of the residents in general, particularly during the night. The survey shows that 5 out of 10 respondents are dissatisfied about the stray dogs and the pollution in the area. Children are not safe due to the danger of dog bites. Pollution due to solid waste combustion on the top of the Hillslopes makes the place uninhabitable. Loud noise is also experienced by the inhabitants because of the quarrying activities on Gunadala hill.

Water connection type

One of the main aspects making the slum unfit to live is the present condition of the water connections. Almost all respondents said they had no access to municipal taps. Although community taps are available, they are only for a limited number of users. There are only two community hand pumps at the bottom of the hill; on the top there are no hand pumps, as the area is on the hill.

5.3 Themes of Livability

The primary survey and related assessment revealed various parameters influencing livability; six major parameters were taken for initial assessment and thereafter 4 parameters focused on the context, and related sub-parameters further linked to each of them, as shown below:

Figure 7

Overall livability



Elements of Infrastructure

The infrastructure sub-parameters are as follows:

- I. Water – Type of supply, frequency, quality problems
- II. Drainage – connection, open drains, water stagnation or overflow
- III. Sanitation – toilets, sewerage network type
- IV. Solid waste collection – type of collection, frequency of bins, solid waste collection

Elements of Mobility

Access to shopping centres and good connections to the major junctions and public spaces are always requirements for livable areas. To analyze this, we set parameters in the mobility theme as follows: Public transport – distance to nearest public stop - different modes of transport - convenient shopping – accessibility

Elements of social development

High quality education and healthcare are the main two sub-parameters to be considered in making any area livable. We have taken sub-parameters to analyze the theme as follows:

- Education – No. of schools, distance to school
- Health – No. of private hospitals, distance to the hospital

Elements of safety

- Type of building – type of structure
- Roads – carriage way
- Streetlights

5.4 Scoring Mechanism

To find the index for slum neighborhoods, we calculated the composite livability index or the slums. The mechanism is based on a scoring we developed on a scale of 1 to 5 (Likert's scale) in which 5 denotes the highest score and 1 denotes the lowest score. These criteria were developed based on household surveys, observation surveys and also stakeholder surveys.

Elements of Infrastructure

An area which has basic infrastructure is essential and crucial for assessing the livable conditions. The following lists such infrastructure:

Water

Type of supply – type of water supply varies from potable to domestic water supply to no water connection at all. As it is an informal settlement, there is only domestic water supply and there may also be cases of no water supply connections, so the scale of assessment is given below:

- 5 – Individual connection for domestic purpose.
- 4 – Individual connection along with submersible pump
- 3 – Community water taps
- 2 – Hand pump
- 1 – No connection

Frequency: frequency of water supply is from 1-2 hours on average in any city, but at least the community water taps and hand pumps provide them with 24 hours of water supply.

- 5 – More than 3hours
- 4 – 2 to 3 hours
- 3 – 1 to 2 hours
- 2 – 1 to 2 hours
- 1 – Community taps and Hand pump(24hours)

Quality problem: quality problems like foul smell, discoloured water or small particles in the water are part of this sub-aspect.

- 5 – Satisfactory quality
- 4 – foul odor or coloured or particulate
- 3 – Colored or particulate
- 2 – Foul odor or particulate
- 1 – Foul odor, coloured and particulate

Drainage

Connection - In the present-day situation, plots with associated drainage frameworks is a required aspect since the absence of a waste framework may prompt water logging inside the territory and additionally in the houses.

- 5 – All plots connected to municipal drainage system
- 3 – Not all plots connected to municipal drainage system
- 1 – No connection to any plots to municipal drainage system

Open drains - open channels prompt unhygienic conditions and furthermore spread diseases.

- 5 – Satisfactory quality
- 4 – Foul odor or coloured or particulate
- 3 – Coloured or Particulate

- 2 – Foul odor or Particulate
- 1 – Foul odor, coloured and particulate

Water stagnation - the proximity to open channels does not take care of the issue of water logging, waterlogging may at present occur because of absence of powerful cleaning.

- 5 – 100 % of total in the slum
- 4 – 80% of total in the slum
- 3 – 50 to 80% of total
- 2 – 20 to 50% of total
- 1 – Less than 20% of road length

Sanitation

Toilets – Removal of excrements is paramount to people. Hence, access to toilets is of critical concern for a region to be called livable. The best choice for sanitation is inside the house as it is more available as well as cleaner.

- 5 – Individual toilets
- 3 – Community toilets
- 1 – Defecation in open

Types of sewerage - The vast majority of the houses nowadays have access to city sewerage facilities. However, in Vijayawada the sewerage and waste system are one and a few territories don't have the consolidated drainage and sewerage waste system.

- 5 – both municipal drainage and sewerage network
- 3 – Soak pit
- 1 – No sewerage system

Solid waste

Functioning waste disposal is essential inside an area as it keeps it spotless as well as decreases the risk of disease caused by unhygienic conditions.

- 5 – primary
- 4 – secondary from bins
- 3 – Primary from household and secondary from unauthorized dumping
- 2 – Primary from household and secondary from roadside
- 1 – No collection from both

The bins kept inside the slum are conspicuous for their unhygienic conditions. Albeit the vast majority of them have been removed, some are as yet present. However, garbage is also dumped at unapproved dumps.

- 5 – No bins
- 4 – Clean bins
- 3 – Dirty bins
- 2 – Dirty bins and unauthorized dumping sites
- 1 – Unauthorized dumping sites

Efficient waste removal becomes more essential in light of the fact that if the waste isn't collected frequently it may turn into a breeding ground for vermin and prompt the spread of illnesses.

- 5 – Every day through primary collection and from bins and dumping sites
- 4 – Every day through primary collection once in two days from dumping sites/bins
- 3 – Every day through primary collection and once a week from dumping yards/bins
- 2 – Every day through primary collection and once a month from dumping yards/bins
- 1 – Every day through primary collection and never from dumping yards/bins

Mobility

A region in segregation diminishes its reasonableness when contrasted with an all-around associated territory. Subsequently a territory inside the base walk capable separation to open transport stop ought to be viewed as perfect.

Public transport

Public transport distance – Public transport stops can be distinctive for various modes. Open transports stops are just for transports and automobiles.

- 5 – 0 to 0.2km
- 4 – 0.2 to 0.5km
- 3 – 0.5 to 0.8km
- 2 – 0.8 to 0.1km
- 1 – Greater than 1 km

Modes of public transport

The more the decisions of open transport the more the openness from the zone increments. In Vijayawada just 4 types of public transportation are accessible: buses, autos, tempo, and cycle rickshaw.

- 5 – Multi model (4 modes)
- 4 – Multi model (3 modes)
- 3 – Multi model (2 modes)
- 2 – Single mode
- 1 – No public transport available

Width

Carriage way – the wider the road, the safer for people live in.

- 5 – 5 to 7m
- 3 – 3 to 5m
- 1 – < 3m

Staircase – there are no roads in the slum but there are staircases in one of the slums and in the other, there are very small staircases and narrow roads.

- 5 – 3m
- 3 – 2m
- 1 – 1m

Social Development

An area which has schools and health facilities is more livable than areas without.

Education

Type of school - a zone having schools for all levels is more livable as it gives pupils of all age groups better access to schooling.

- 5 – Pre-primary, primary, middle, secondary and senior-secondary school
- 4 – No separate school for every type but all are present
- 3 – Senior-secondary, secondary, middle and primary school
- 2 – Secondary, middle and primary school
- 1 – Middle and primary school

Average distance to nearest school – an area which is less than 0.5km away from the school is more livable.

- 5 – 0.2km
- 4 – 0.2 to 0.8km
- 3 – 0.8 to 0.1.5km
- 2 – 1.5 to 2.0km
- 1 – > 2km

Safe access to school – areas which have fewer intersections between home and school are more livable because of the safety of the children.

- 5 – No intersection
- 3 – 1 to 3 intersections
- 1 – More than 4 intersections

Health

Distance to hospitals – in cases of emergency, it is good if the hospitals are nearby, whether private clinics or a government hospital.

- 5 – 0.2km
- 4 – 0.2 to 0.8km
- 3 – 0.8 to 0.1.5km
- 2 – 1.5 to 2.0km
- 1 – > 2km

Types of hospitals – in cases of emergency, it is good if the hospitals are nearby, whether private clinics or a government hospital.

- 5 – Private and government hospital
- 3 – Only government hospital
- 1 – Only private hospital

Safety

Street lights – Streetlights play a vital role in creating safety in slums.

- 5 – maximum 30m
- 3 – Between 30-60m
- 1 – Not present

Landslides – As the slums are located on the hills, there have been 3-4 cases of landslides in the past 8 years, so landslides are also taken as one of the

aspects to measure the livability in that area.

- 5 – No landslides
- 3 – Small stones
- 1 – Big footwalls

Housing – There are more semi-pucca houses in the slum rather than kutcha houses, making them unlivable due to the landslides.

- 5 – Pucca
- 3 – Semi-pucca
- 1 – Kutcha

5.5 Calculation of Livability Index

To calculate the Livability Index, weightages have been taken depending upon the parameters from 1 to 10 which interpret the importance of the sub-parameters at various levels.

Scale

- Infrastructure – 3
- Mobility – 2
- Social development – 2
- Safety – 3

Infrastructure

- Water supply – 3
- Drainage – 2
- Sanitation – 3
- Solid waste disposal – 2

Water supply

- Supply type – 4
- Adequacy – 3
- Quality issues – 3

Drainage

- Connection to plot – 4
- Open drains – 4
- Incidence of water logging – 2

Sanitation

- Access to toilets – 7
- Type of sewerage system – 3

Solid waste disposal

Collection type – 5
Adequate no. of bins – 2
Solid waste collection – 3

Social development

Schools – 4
Health – 6

Schools

Type of school – 2
Average distance – 5
Safe access path– 3

Average distance to diff. type of schools

Pre-primary – 3
primary – 3 Middle school – 2
Secondary school – 2
Senior-secondary – 2

Safe access paths

Pre-primary – 4
Primary – 3
Middle school – 1
Secondary school – 1
Senior school – 1

Health

Average distance to private health centers – 4
Average distance to nursing homes – 6

Safety

Housing – 4
Landslides – 4
Streetlights – 2

Mobility

Public transport – 6
Right of way design – 4

Public transport

Bus – 6
Auto – 2
Rickshaw – 2

Right of Way design

Carriage way – 7
Staircase – 3

Table 3

Index Calculation – Arul Nagar Slum

DWELLING UNIT	INFRA-STRUCTURE INDEX	SOCIAL DEVELOPMENT INDEX	MOBILITY INDEX	SAFETY INDEX	COMPOSITE LIVABILITY INDEX
1	8.66	5.6	4.88	5.6	6.185
2	6.78	6.72	6.56	5.8	6.465
3	7.22	6.24	5.36	6.6	6.355
4	7.26	5.76	5.36	5.2	5.895
5	7.28	7.52	3.68	5	5.87
6	6.82	8.16	4.4	6.8	6.545
7	6.66	7.04	6.08	7.2	6.745
8	7.38	6.56	3.2	4.8	5.485
9	8.18	5.12	6.56	6.6	6.615
10	7.06	6.48	3.92	8.2	6.415
11	7.28	6.48	4.64	4.4	5.7
12	6.78	6	6.8	3.4	5.745
13	8.34	5.92	5.36	5.2	6.205
14	7.24	7.68	5.36	8	7.07
15	5.38	7.12	3.92	4	5.105
16	7.06	7.68	4.16	6.6	6.375
17	6.18	5.84	5.84	5.8	5.915
18	7.18	5.36	3.44	6.8	5.695
19	5.74	4.96	6.56	5	5.565
20	5.5	6.08	3.92	6	5.375
21	6.4	6.72	4.88	7.2	6.3
22	5.72	5.44	6.56	4.8	5.63
23	5.58	6.88	5.12	8.2	6.445
24	7.7	7.6	5.6	5	6.475
25	8.14	8.08	3.92	5.2	6.335
26	6.92	6.32	4.16	3.4	5.2
Total	6.94	6.51	5.01	5.8	6.07

In the above table, we can see the index values are very low in mobility and safety at 5.01 and 5.8, respectively, and also each parameter has a separate index elaborated in detail. The Radar chart describes the least seen parameters in the slum needing to be improved to make the place more livable. Mobility is one of the parameters which says that the place is not fit to live in.

AN APPROACH TO MEASURE LIVABILITY OF SLUMS IN HILL SLOPE AREAS
PART 5 – ANALYSIS AND DISCUSSION

Table 4

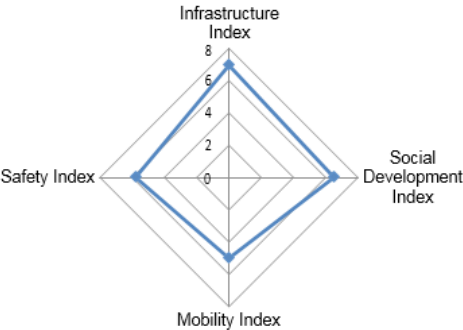
Index Calculation – Bethlaham Nagar Slum

DWELLING UNIT	INFRA-STRUCTURE INDEX	SOCIAL DEVELOPMENT INDEX	MOBILITY INDEX	SAFETY INDEX	COMPOSITE LIVABILITY INDEX
1	6.28	4.64	6.08	6.8	5.95
2	6.36	6.24	3.68	6.4	5.67
3	6.46	6.56	6.56	4.8	6.095
4	6.04	7.04	3.44	5.8	5.58
5	4.12	4.52	4.96	7.4	5.25
6	5.68	8.92	7.12	6.8	7.13
7	5.14	5.76	5.12	4.2	5.055
8	5.88	6.96	6.4	6	6.31
9	6.88	6.28	3.2	7.2	5.89
10	7.34	5.32	4.4	6.4	5.865
11	7.36	5.16	6.4	5	5.98
12	7.44	6.2	4.24	5.8	5.92
13	6.38	5.44	7.12	5.2	6.035
14	6.48	5.04	3.76	5	5.07
15	7.2	6.92	4.4	5.2	5.93
16	7.42	6.28	7.12	7.2	7.005
17	7.18	6.52	5.12	4	5.705
18	6.5	7.48	5.84	7.4	6.805
19	6.72	3.76	3.76	7.4	5.41
20	6.06	4.64	4.96	6	5.415
21	6.66	6.76	6.4	4.2	6.005
22	6.04	5.0	4.24	6	5.32
23	7.9	4.76	6.56	8.8	7.005
24	6.32	7.4	3.76	3.2	5.17
25	3.5	5.92	4.4	5.8	4.905
26	5.16	7.04	6.56	5.8	6.14
27	4.4	5.64	5.68	6.8	5.63
28	3.86	6.04	6.4	3.4	4.925
29	5.04	4.04	4.24	6	4.83
30	5.8	6.84	5.2	6.4	6.06
31	6.42	5.28	5.12	5.6	5.605
32	5.12	4.08	4.0	7.4	5.15
33	5.72	7.8	6.56	6.6	6.67
34	4.82	7.24	3.2	6	5.315
35	7.88	7.24	5.44	4.2	6.19
36	3.48	7.08	6.64	7.6	6.2
37	5.56	4.32	5.36	5.6	5.21
Total	6.02	6.00	5.23	5.93	5.79

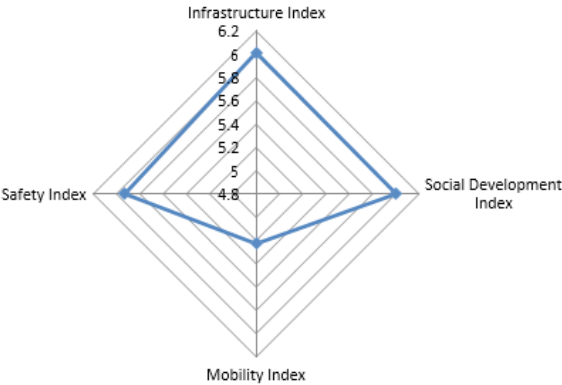
In the above table, we can see the index values are very low for mobility and safety, at 5.01 and 5.8 respectively. Each parameter has a separate, more detailed index.

The Radar charts describes the least seen parameters in the slum needing to be improved to make the place more livable. Mobility is one of the parameters indicating that the place is not fit to live in. ♦

Figure 8
Radar chart showing the Composite Index of Arul Nagar Slum



Radar chart showing the Composite Index of Bethlaham Nagar Slum



PART 6 CONCLUSION

The informal communities of Vijayawada play a major role in providing a proper urban setting in the city, as these informal settlements are located in various pockets and spread over 64 sq kms of urban area. There are 110 such settlements in general, particularly the settlements on hill slopes, canal bunds and river banks, creating unhygienic environments and hence unlivable conditions. The identified slums of Arul Nagar and Bethlaham have been studied in depth in terms of their locations, livable conditions and analyzed to understand the degree of unhealthy conditions through the social development index and livability index. As per the study it is evident that the index values

for Arul Nagar and Bethlaham are very low for mobility and safety, at 5.01 and 5.8 respectively. The Radar chart also describes that, in order to make the places more livable, mobility is one of the parameters that needs to be improved. These communities are far below the acceptable limits despite certain interventions /facilities provided by the local government. Basic facilities such as water supply, drainage and social infrastructure, accessibility to nearby facilities do not meet the standards. These settlements have to be viewed in the context of the livability index. The shortcomings mentioned must be addressed to bring these communities into the mainstream. ♦

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