A Walking-Centric Urban Livability Assessment of Baguio City using Open-Source GIS Data

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Abstract

Urban livability measures how well a city can support the well-being of its residents. In population dense, rapidly urbanized cities, assessing livability while considering walkability is important in policy making and urban planning. Baguio City conducts its own livability assessment but doesn't fully consider the 4 dimensions of livability recommended by the World Health Organization (WHO). This study assessed Baguio City's urban livability on a grid and barangay level based on the 4 dimensions: convenience, amenity, health, and safety, with 15 indicators adapted from Fu et al. (2019). Open-source data was used for the livability indicators and priority values per indicator were provided by experts and scored using the Analytical Hierarchy Process (AHP). Results showed that moderately livable areas are in the city center and lower city zones are of declining livability, and that no barangays were classified as fully or least livable. A paired two-sample T-test between the computed Urban Livability Index (ULI) and the city governments' own assessment suggest that ULI from both methods are not significantly different despite dissimilarities in the factors considered. The results of the study provide alternative insights for Baguio City that are useful in crafting policies concerning the well-being of its residents. The methods used are replicable and scalable, enabling evidence-based decisions across various urban locales.

1. Introduction

In 1900, 6% of the global population lived in cities with more than 100,000 people, which had risen to 16% by 1950, 39% by 1980, then estimated to 57% by 2023 (Davis, 1972 in Weeks, 2010). Weeks (2010) argued that, with the significant urbanization and population growth over the past 200 years, it is no longer sufficient to define urban areas as simply nonagricultural. Due to its complex nature, urban areas differ in how each caters to each of its residents' needs. To quantify exactly how well, urban livability is defined as the extent an area can support its residents' well-being (Ahmed et al., 2019). The assessment of urban livability can serve as a basis for improvements in policy making and urban planning.

In rapidly urbanized cities in Asia, the lack of funding for sustainable transportation systems resulted in increased traffic congestion levels (Tsumura et al., 2019). One sustainable form of transportation is walking due to its benefits in enhanced mobility and lessened carbon gas emissions (Ilagan, 2025). In Baguio City, walking is the second-ranked means of transportation at 10%, following Public Utility Jeepneys (PUJ) (de Guzman, 2012 in Ranosa et al., 2017). The viability of walking as a preferred mode of transportation is dependent on the built environment meeting its residents' needs. In Baguio city, walking is an important factor to consider in determining livability, however, existing methods of assessment tend to be limited in transferability (Györi and Cabrera-Barona, 2019).

This study aims to assess the urban livability of Baguio City based on set indicators from the four main dimensions of livability as set by the World Health Organization (WHO), to determine the priorities of individual indicators through the Analytical Hierarchy Process (AHP), to compare this study's livability assessment with the existing urban livability assessment of the government. Further, to analyze the livability results in relation with the city's existing Land Use Plan to assess alignment between functional land use and perceived livability.
The Baguio City government conducts a livability assessment per barangay based on ten specific dimensions of livability, however, the WHO recommended dimensions are not fully considered in the current framework. Therefore, it is important to explore livability from a different perspective. This study aims to determine whether the WHO's livability dimensions align with and can be applied to the context of Baguio City. The study was limited to considering livability indicators as independent due to the nature of the AHP method. The walkway conditions found by Ranosa et al. (2017) were considered to have been met throughout the city. The assessment methods may be used as a resource for policy making and urban planning, where the insights can highlight necessary improvements. As the study is designed to be repeatable, it may be used in the broader scale of urban planning and development in other locales.

2. Related Studies

Due to the resident-dependent nature of urban livability, different methods of assessment are plausible. Long et al. (2024) conducted an open-source data-based assessment of livability in Shanghai based on five dimensions: education, health, recreation, transport, and living services, geolocalized by Residential Building Clusters (RBCs). Housing prices and building age were considered as urban quality indicators (Long et al., 2024). Jodder et al. (2025) similarly employed a GIS-based multi-criteria approach in Khulna City using 22 spatial indicators, with convenience, amenity, safety, and health as points of focus. These studies may help determine the distance-based reach of services but mainly focus on availability over accessibility by transportation methods such as walking, a consideration highly relevant to cities such as Baguio. This study aims to highlight the relevance of walkability within the scope of livability.

Conversely, Paul (2020) explored livability in terms of perception by using survey data collected in Kolkata. Belonging socially, access to culture, and community connections were concluded as more related to perceived livability than employment or income. While this method provides a different perspective, it is limited in urban design due to its non-geographic specific nature.

Zhang et al. (2023) used a more integrative approach in assessing the livability in Longgang District, Shenzhen, by combining Amap, China's own widely used map service, and government-sourced spatial data with expert interviews, highlighting governance-related problems such as the unequal distribution of facilities and inadequate planning. While comprehensive, their study relies on local-centered and government-sourced data potentially unavailable in other areas. In contrast, by considering livability indicators using open-source GIS data, this study offers a scalable, data-based insight into the livability of Baguio city.

Although these studies each contribute meaningfully to the understanding of the different dimensions of urban livability, each one is characterized by certain limitations. Spatial studies in the cases of Long et al. (2024) and Jodder et al. (2025), did not consider the walkability to different facilities. Perceptual studies, as the case of Paul (2020), are insightful in terms of everyday experiences but are qualitatively based and don't seek to add insight in the case of spatial-based urban livability indicators. The use of the mixed-methods approach by Zhang et al. (2023) adds analytical depth by merging qualitative and quantitative inputs; however, its reliance on local-specific data poses restrictions on replicability in data-poor contexts.

3. Methodology

3.1 Study Area

Baguio City, classified as highly urbanized and located in the Cordillera Administrative Region (CAR), covers about 57.49 km² and consists of 129 barangays (Estoque and Murayama, 2011). Initially designed in 1905 by American architect Daniel Burnham for the housing of up to 25,000 residents, its population has grown tremendously, from 489 in 1903 to 366,358 in 2020 (Estoque and Murayama, 2011; PSA, 2020).

To accommodate the significant population increase, Baguio City has undergone rapid urbanization, where 44.7% of the city composed of urban areas by 2011 (Mascapac et al., 2024). Between 2011 and 2019, more than 400 hectares of vegetation was transformed into urban land use, with over 50% of the land forecasted to be developed by 2035 (Mascapac et al., 2024).

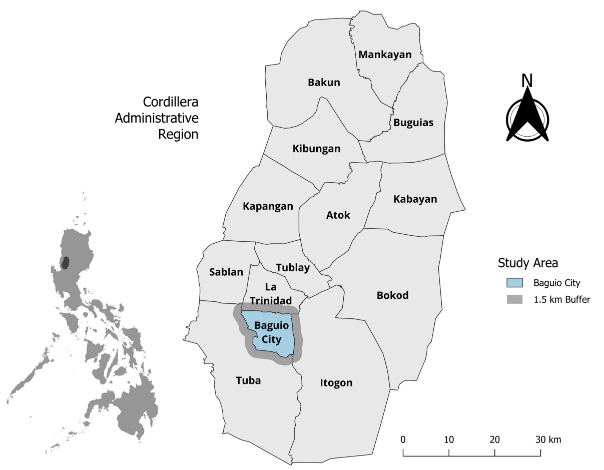

Figure 1. Baguio boundaries with 1.5km buffer as part of the study area

Shown in Figure 1 is the location of Baguio City. A 1.5km buffer was created to account for spatial interactions at the City's administrative boundaries.

3.2 Methodological Framework

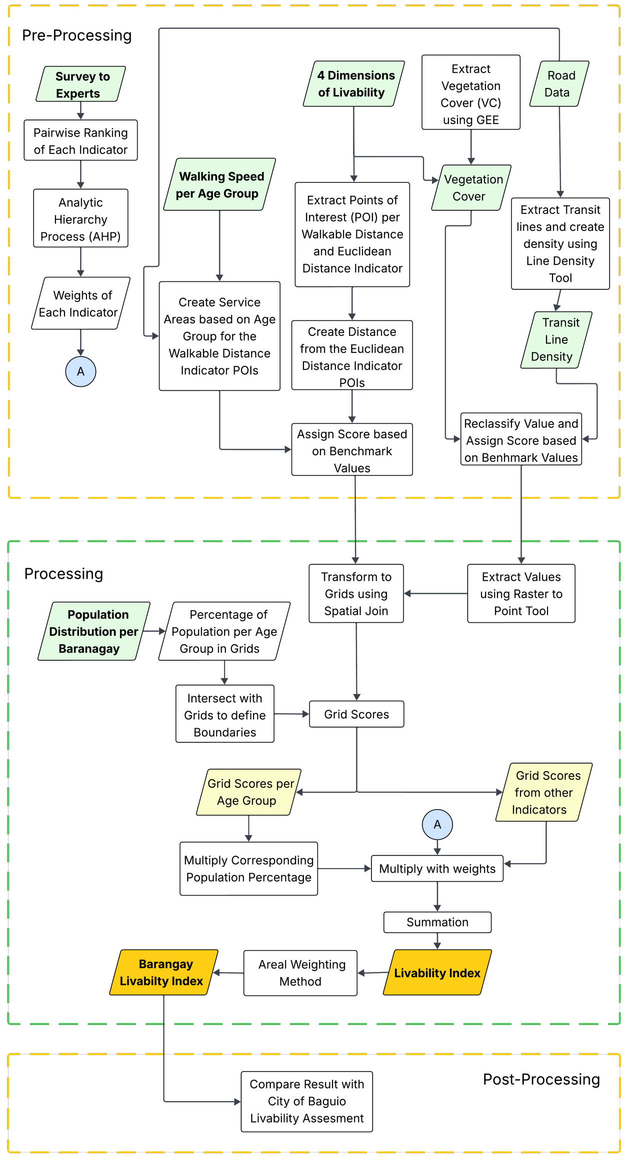

Figure 2. Geospatial Framework for Computing Urban Livability Index (ULI)

The framework used to compute Baguio's ULI as seen in Figure 2 has three primary stages: pre-processing, processing, and post-processing. For pre-processing, data is extracted from various sources—points and road networks from OpenStreetMap (OSM), and vegetation cover derived from NDVI values using Google Earth Engine (GEE). Indicator scores are then assigned based on benchmark values sourced from relevant literature. In the processing stage, extracted data is transformed into grid cells, which serve as the study's smallest spatial units. Livability scores are computed by applying weighted priority values to each indicator. In the post-processing stage, the computed ULI is compared with Baguio's own assessment to determine accuracy and relevance.

3.3 Livability Indicators

The main factors considered for livability were classified into 4 main categories by the WHO: convenience, amenity, health, safety. 15 individual indicators of livability were adapted from Fu et al. (2019). Each indicator was assigned the corresponding analysis type used, either Walkable Distance, Euclidean Distance, and Density, as shown in Figure 3.

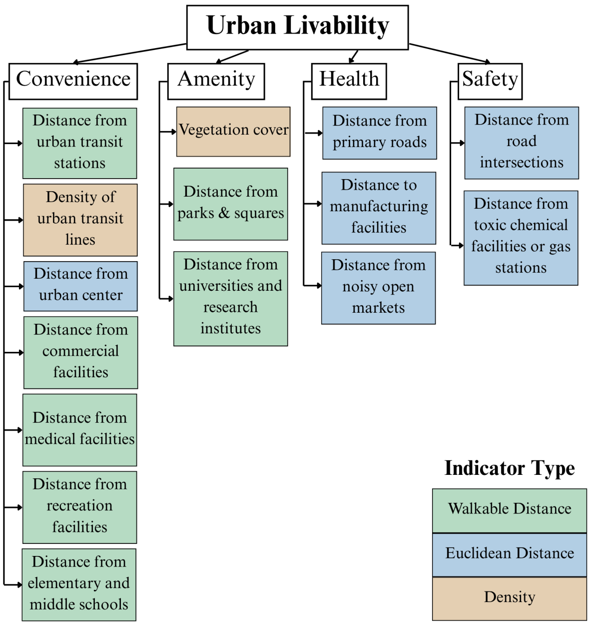

Figure 3. Individual Indicators of Livability.

The Walkable Distance indicator was used for indicators where assessing walkability was relevant, which was obtained with respect to each age group's walking speed. Meanwhile, the Euclidean Distance indicator was used for indicators where the general distance from the facility was the required component. In the case of the two indicators classified under Density, the spread over the whole city was considered.

The Points of Interest (POIs) for the Walkable Distance and Euclidean Distance indicators were obtained using OpenStreetMap (OSM) via QGIS using the plugin QuickOSM. Under QuickOSM, Quick Query was used to set the appropriate Keys and Values to obtain the needed POIs.

Table 1 summarizes the scores for each indicator. For all walkable distance indicators, the acceptable walking time was based the findings of Ranosa et al. (2017), who concluded that commuters were willing to walk 5-10 minutes, equivalent to 2 street blocks, provided that set walkway conditions were met: sidewalk with benches, shade provided by trees, and good landscaping.

For the non-walkable distance indicators, the following considerations were made per livability dimension in Table 1. Under Convenience, the urban center used in this study was the Central Business District (CBD) of Baguio City. The CBD is one of the central places in an urban center (Murphy, 2007). The CBD's extent was not explicitly defined, however, the barangays containing such were available in the city's information website (City Government of Baguio, n.d.). The central point of these barangays was used as center and a buffer of 8810 m was created, based on Fu et al. (2019). Meanwhile, the livable density of urban transit lines was set at $4km/km^2$ as specified in study of Fu et al. (2019).

For Amenity indicators, only vegetation cover was considered non-walkable. The review of Fu et al. (2022) on the benchmark for livable vegetation cover was considered, which found that thermal comfort improves when coverage exceeds certain thresholds: 55% in Shenzhen, China; 50% tree cover in dense areas of Cairo, Egypt; and 60% GCR with reflective surfaces in Campinas, Brazil and Mendoza, Argentina. Based on these, the lowest threshold was used as the benchmark for livable vegetation cover.

For Health indicators, the lower distance limit from primary roads was based on the findings of Ramos and Blanco (2019), who concluded that particulate matter (PM) concentrations are evident from within 40 meters of primary roads. Additionally, the findings of Avsar and Gonullu (2005) was able to determine that noise reach as far as 175 meters when no noise preventative precautions are taken. These findings were also considered as the distance limit in the case of noisy open markets. Meanwhile, the distance limits from manufacturing facilities were based on De Roos et al. (2010), who concluded that distances of 805 and 3220 meters were considered safe when evaluating the risk of Non-Hodgkin Lymphoma.

As for the Safety indicators, the distance limit for road intersections was based on Avelar et al. (2019), who concluded that a threshold distance of 76.2 meters would be adequate for studies evaluating safety at intersections as accidents tend to happen near intersections. For toxic chemical facilities or gas stations, the Philippines has no regulations set for appropriate distances from these facilities (Kukfisz et al., 2022). Thus, the researchers used a Batangas City local ordinance as proxy for threshold distance in this study, which set 300 meters as a safe distance (Batangas City, 2014).

Indicators	Score		
	1	0.5	0
All Walkable Distance Indicators	<5 mins	5-10 mins	> 10 mins
Distance from urban center	>8810 m	-	≤8810 m
Distance from primary roads	>175 m	40m - 175m	<40 m
Distance to manufacturing facilities	>3220m	805m - 3020m	<805 m
Distance from noisy open markets	>175 m	-	≤175
Distance from road intersections	>76.2 m	-	≤76.2 m
Distance from toxic chemical facilities or gas stations	>300 m	-	≤300 m
Density of urban transit lines	$>4km/km^2$	-	$\leq 4km/km^2$
Density of vegetation cover	>50%	-	≤50%

Table 1. Assigned Scores per Indicator.

3.4 Data Gathering

3.4.1 City Boundaries. The shapefile containing the administrative 4 level boundaries of the Philippines was obtained from the Humanitarian Data Exchange (HDX) courtesy of the National Mapping and Resource Information Authority (NAMRIA) and the Philippine Statistics Authority (PSA).

3.4.2 Age Group and Walking Speed. The age groups are based on the UN standards age group classification for general mobility (UN, 1981). As walking to different facilities was considered, children must be able to walk by themselves, which usually begins at age 7 (Schoeppe et al., 2015). Thus, the researchers modified the 0 to 14 years old age group to 7 to 14 years old, with the final age groups used seen in Table 2.

The walking speed classifications per age group used, shown in Table 2, were derived from Fitzpatrick et al. (2006) in Mañago et al. (2025) who considered the same Age Group classifications.

Age Group	Walking Speed
65+	1.03 m/s
45-64	1.395 m/s
25-44	1.445 m/s
15-24	1.445 m/s
7-14	1.375 m/s

Table 2. Walking Speed per Age Group.

3.4.3 Population Distribution. The population data of Baguio City at the barangay level was based on the dataset from the HDX, which was referenced from the PSA. The population data was categorized by age group per barangay and the percentage from the whole population of each age group was computed.

3.4.4 Roads. The roadways and walkways of Baguio city were obtained using OpenStreetMap (OSM) via QGIS using the plugin QuickOSM. Under QuickOSM, Quick Query was used to set Keys and Values to obtain the necessary walkable roads, primary roads, and transit routes.

3.4.5 Vegetation Cover. The vegetation cover (VC) was calculated from the NDVI values processed in GEE using Sentinel-2 Level-2A images. Two images were mosaicked to fit the study area. The images are dated February 19 and 21, 2024. The selection of image was based on the least cloud cover over the area, which occurs during the dry season between February to April. VC computation was based on Equation 1.

$$VC = \frac{NDVI - NDVI_s}{NDVI_v - NDVI_s} \quad (1)$$

where $NDVI_s$ = NDVI of soil
$NDVI_v$ = NDVI of vegetation

The NDVI of soil is computed as the average NDVI of sample points of bare soil areas. The maximum NDVI value is set to be the NDVI of vegetation. This is similar to the method used by Zhang et al. (2019).

3.4.6 Indicator Priorities Computation. To evaluate the priority values, a pairwise comparison of each indicator was conducted. It was scored based on Saaty (1987) scale of importance. Experts from relevant fields were invited to perform the pairwise comparison. The consistency ratio (CR) of each expert was computed and only those with CR of less than 0.1, the tolerable value as suggested by Saaty (1987), were considered for the computation of the final weight vector used to derive the final priority values per indicator.

3.5 Data Processing

3.5.1 Processing per Indicator Type. The Network Analyst Tool was used to generate service areas for the walkable distance indicators. These service areas represent the area residents can walk towards the POI within the acceptable walking time. The walking time computed from different walking speeds were used as the impedance. Service areas were generated per age group in each walkable distance criteria, a sample is shown in Figure 4.

The service areas were assigned their corresponding scores and transformed to grid cells by spatial intersection. The grid cells used were hexagonal grids of size approximately $2500m^2$. For indicators involving Euclidian distances, buffers rings were created, scores were assigned to each ring, and the layer was transformed to the grids via spatial intersection. For density indicators, the density raster used for the urban transit line indicator were reclassified to assign scores to each cell. Raster values were extracted using points with corresponding grid cell value. This were later joined with the grid cells via join function.

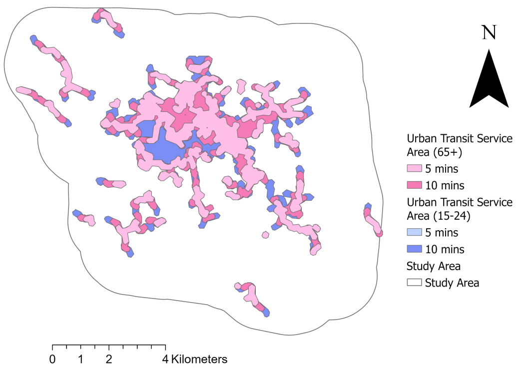

Figure 4. Service Area for Urban Transit Station with Age Groups 65+ and 15-14.

3.5.2 Walkable Distance Indicator Score. The indicators for walking have 5 different scores for each indicator corresponding to the 5 age groups. These are then resolved to one score per indicator using Equation 2.

$$S_{WDI} = \sum \%POP_{AG} * S_{AG}, \quad (2)$$

where S_{WDI} = score of walkable distance indicator
$\%POP_{AG}$ = percent of population of an age group
S_{AG} = the score of service areas of an age group

3.5.3 Sensitivity Analysis of Priority Values. The priority values were derived from the combined opinions of multiple experts. While aggregating expert judgments helps reduce individual subjectivity, it does not eliminate it entirely. A sensitivity analysis to evaluate the quality of the group judgment similar the one-at-a-time (OAT) method proposed by Chen et al. (2010) was performed. In this approach, the sensitivity of the priority values was assessed by systematically excluding one expert at a time and calculating the standard deviation (SD) of the resulting changes in priority values. This method allows for the identification of whether any single expert's judgment had a significant influence on the overall group decision.

3.5.4 Urban Livability Index. After determining the priority values of each individual indicators, the ULI was then computed using Equation 3.

$$ULI = \sum w_i * S_i, \quad (3)$$

where w_i = priority values (weights) of each indicator
S_i = score of each indicator

The ULI values range from zero to one, with one indicating that all the livability criteria were satisfied. Identification of the least livable, declining livabilty, minimum compliance, moderately livable, and livable values were based on the benchmark set by Baguio City rescaled to fit the range.

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3.5.5 Transformation to Barangay Livability Index. The grid values were used to derive the ULI of each barangay in Baguio City. The areal weighting method was used, where the area of each grid over the area of the barangay was the grid score multiplier using Equation 4. The grids along the borders of each barangay were halved by spatial union to preserve the integrity of the barangay boundaries.

$$ULI_{brgy} = \frac{\sum A_i * ULI_i}{A_{brgy}}, \tag{4}$$

where ULI_{brgy}= livabilty index of the barangay
ULI_i= livabilty index of each grid
A_i = area of the grids
A_{brgy} = area of the baranagay

3.5.6 Comparison with Baguio City's own assessment. The values of this study's livability results were rescaled using Equation 5 to fit the city's own assessment.

$$ULI_{RS} = (ULI * 4) + 1, \tag{5}$$

where ULI = Urban Livabilty Index
ULI_{RS} = rescaled ULI value

4. Results

This section outlines the outcomes of the study, starting with the priority values for livability indicators based on expert input. It then details the computed ULI for Baguio City at both the grid and barangay levels. A comparative analysis with the city's official livability assessment follows, highlighting alignments and discrepancies.

4.1 Priority Values of Indicators. The aggregated priority values of indicators from eight experts are shown in Table 3. The distance to urban transit stations was the top priority for most experts, hence, it is the top priority in the aggregated judgements. Notably, vegetation cover received the lowest priority among the evaluated criteria.

Indicators	Priority Values [%]
Distance from urban transit stations	13.775
Density of urban transit lines	4.825
Distance from urban center	9.025
Distance from commercial facilities	8.420
Distance from medical facilities	8.032
Distance from recreation facilities	6.686
Distance from elementary & secondary schools	8.794
Vegetation cover	2.355
Distance from parks & squares	6.171
Distance from universities & research institutes	6.339
Distance from primary roads	6.869
Distance to manufacturing facilities	6.343
Distance from noisy open markets	4.180
Distance from road intersections	4.585
Distance from toxic chemical facilities or gas stations	3.602

Table 3. Priority Values for Livability Indicators

The quantified sensitivity of the group judgment is presented in the Table 4. The low standard deviations (SD) suggest that the experts reached a strong consensus, as the exclusion of any single judgment led to minor changes in the overall priority values. The highest SDs were observed when Expert 8 was excluded. This deviation may be attributed to the expert's background as a real estate broker and appraiser, which differs from the predominantly engineering and architectural expertise of the other participants. It is worth noting, however, that Expert 5, who comes from a medical background, produced relatively low SDs, indicating alignment with the group despite disciplinary differences. Overall, the average SD across all experts was 0.496%, indicating that the results were generally robust and not significantly affected by the exclusion of individual judgments.

Excluded Expert	SD %	Excluded Expert	SD %
Expert 1	0.403	Expert 5	0.368
Expert 2	0.797	Expert 6	0.282
Expert 3	0.255	Expert 7	0.532
Expert 4	0.465	Expert 8	0.870

Table 4. Sensitivity per Excluded Expert

Generally, there is no predetermined number of experts that should participate as it depends on the scope, complexity, and available resources of the study. A large expert panel can enrich the analysis by incorporating diverse viewpoints with the subjectivity of the topic. However, an increased number of experts heightens the likelihood of divergent judgments, leading to low consensus among experts. This could undermine the reliability and robustness of the computed priority values. A panel of eight experts from different fields is diverse enough to account for different viewpoints. The resulting sensitivity also shows that consensus was achieved. Additionally, Sağir Özdemir and Saaty (2015) found that 7 or 8 is the optimal number of experts to achieve an agreement in group judgments.

4.2 Baguio City Urban Livability Index (ULI).

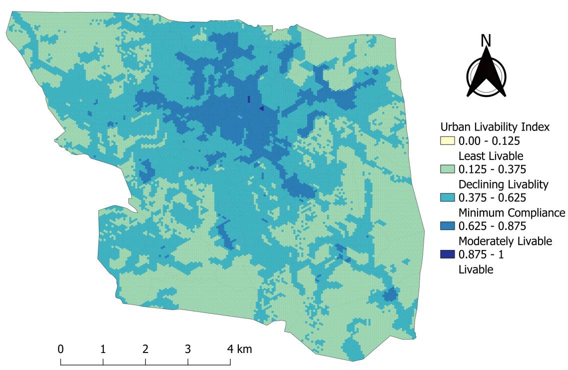

Figure 5. ULI of Baguio City at grid level

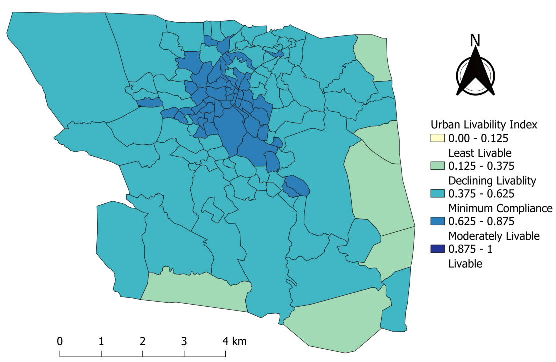

Figure 6. ULI of Baguio City at Barangay level

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Based on the set methods and using the priority values, the ULI of the city was computed. At the grid level, shown in Figure 5, Moderately Livable areas clustered towards the upper middle of Baguio City, where some patches were found to be Livable. This area is also where the CBD is located. In contrast, the periphery areas were generally found to be of Declining Livability, whereas areas in between the urban core and periphery were found to be of Minimum Compliance. At the barangay level, shown in Figure 6, no barangays were categorized as Livable, 48 barangays as Moderately Livable, 75 barangays of Minimum Compliance, and 6 barangays were of Declining Livability.

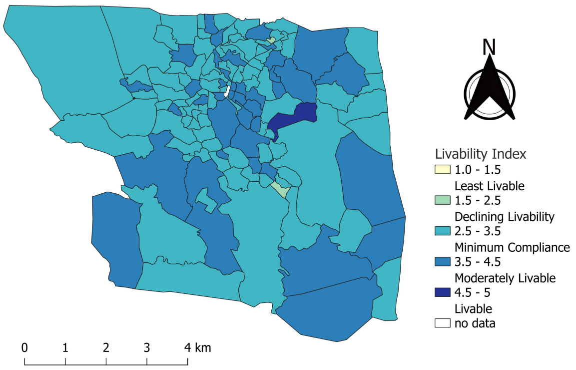

Figure 7. 2024 Livability Index as per Baguio's Own Assessment

The Livability Index obtained through the city's own assessment is shown in Figure 7. A paired two-sample T-test between the computed ULI and the city's own assessment was performed with the assumption that the mean difference is zero. The computed p-value, 0.414, indicated no significant difference in the livability score produced by the two methods. The intercept was set with the assumption that the two variables were equal. The R^2 value of 0.96 and the slope value close to 1 show that the resulting livability scores from both methodologies are in strong agreement. Figure 8 further supports the results of the T-test, which indicates no significant difference between the scores from the two assessments.

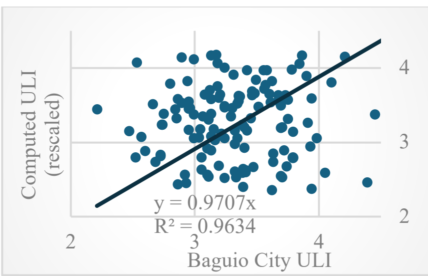

Figure 8. Scatterplot of Computed ULI (rescaled) vs Baguio City's ULI

The livability conditions were compared to the 2013-2023 Land Use Plan (City Planning, Development, and Sustainability Office, n.d.) shown in Figure 9. Most of the areas under declining livability were not residential areas, rather, areas classified as Vacant Forested Areas, Watershed and Protected Forest, and a Special Use Zone. Generally, residential areas were found to exhibit Minimum Compliance, except for certain clusters near Institutional, Commercial, and Park and Recreation Zones that are Moderately Livable. Residential areas adjacent to vacant forested lands were of Declining Livability. These insights show that the configuration of land use in an area may affect its own and neighboring areas' livability classifications.

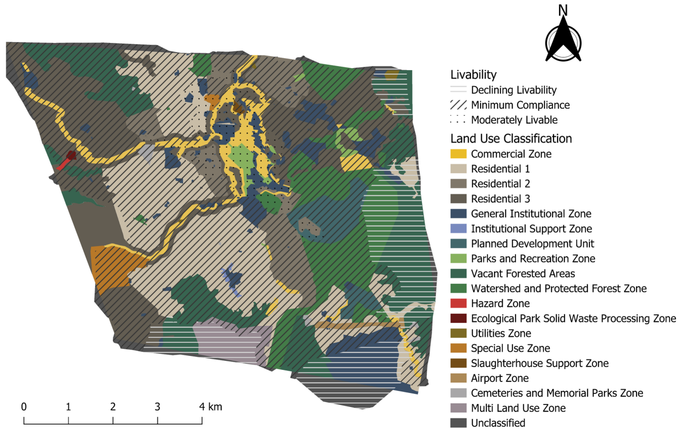

Figure 9. Comparison of Livability Conditions and the 2013-2023 Land Use Plan of Baguio City

5. Discussion

In this study, the four main categories for livability are referenced from the WHO, which are convenience, amenity, health, and safety (Higasa, 1977 in Fu et al., 2019). Meanwhile, the Baguio City government considered 10 dimensions of Barangay livability: A Healthy Place, With Food Sources, Safety and Security from Crime, Economic Opportunities, Accessibility, Mobility Choices, Presence of Essential and Retail Services, Safety and Security from Hazards, Community Spaces and Engagement, and With Clean Water Supply. Two dimensions of livability present solely in the city's own assessment are Economic Opportunities and With Clean Water Supply.

15 individual indicators of livability were considered in this study, while Baguio City set four to seven indicators per dimension. Some indicators only present in this study include distance from urban center, distance from primary roads, distance from toxic chemical facilities or gas stations, and distance to manufacturing facilities. Meanwhile, indicators only considered in the city's assessment include fire response time, water quality in rivers and creeks, traffic accidents, and access type to barangay. Compared to this study's assessment, which scored on walking distance, euclidean distance, and density, the city made considerations for indicators with specific scoring classifications such as the water quality being within the set standard of the city, how many traffic accidents occurred in a year, and presence retail and services within a barangay, all of which were scored from 1 to 5.

Baguio City's highest priority dimension, Food Sources, was partially considered under the commercial facilities indicator as the facilities includes restaurants and fast-food establishments. For the 2nd highest priority, Safety and Security from Hazards, distance from road intersections was used as proxy but doesn't fully make the same considerations. Additionally, the 3rd highest priority dimension, With Clean Water Supply, was not considered in this study. Thus, even with the paired two-sample T-test indicating no significant difference between the index values, there are fundamental differences in the higher priority factors considered that may be attributed to the difference in resulting ULI values.

The ULI decrease in barangays Fort del Pilar and South Drive may be attributed to low scores in the 1st and 3rd highest ranked priority indicators of this study, urban transit stations and elementary and secondary schools. These indicators were considered in the city's own assessment but under dimensions of lower priority at 7th and 6th out of 10 respectively. Due to the differences in factors and indicators considered and without the data collected by the city itself, the researchers were unable to consider exactly which unassessed factors caused lower scores when comparing both assessment methods. However, it may be generally attributed to the differences in dimensions, factors, and priorities of this study with the city's own assessment.

6. Conclusion and Recommendations

The methodology employed in this study successfully determined the ULI of Baguio City both at the grid level and the barangay level. The grid level data allows hyper-local presentation of livability conditions. In the urban setting, livability may vary block by block; barangays may appear average overall while grid-level data can reveal small pockets of notable difference compared to its barangay. On the other hand, barangay level findings can be easily communicated to local government bodies encouraging data driven projects uplifting living conditions of constituents.

The priority values were successfully computed using the AHP method. Although the experts are from different fields of specialization, the sensitivity results suggest that there is a high degree of agreement. This enhances the credibility of the results as individual and disciplinary bias is mitigated. Furthermore, the comparison with the city's own assessment revealed no significant difference between the livability scores produced. This further validates that the results of this study were able to capture the current conditions of livability in the area.

While the findings of this study offer valuable insights, its limitations must be acknowledged. The set walkway conditions for walking time, which were assumed to have been met, may be considered in future research. Data specific to the study area was unavailable and proxy values were adapted for some indicators, which may not reflect the area's actual condition. Due to the open-source nature of OSM data, the possibility of POIs under each indicator being incomplete, especially in more rural areas, should be noted. Future researchers may opt to further validate the ground-truth of the data.

The AHP method was used to determine the priority values, however, it assumes that factors are independent (Ilagan et al., 2025). This overlooks the multidimensionality of the indicators, as in the case of distance to urban transit stations and density of urban transit lines. Compared to convenience, fewer indicators were considered for the amenity, health, and safety categories. It is recommended to use an alternative multi-criteria decision process that addresses the multi-dimensionality of the criteria. Indicators for each dimension of livability may also be refined and additional indicators related to safety and health should be explored.

The comparison with Baguio City revealed that both methods yielded similar outcomes. However, it is ill advised to use the two methods interchangeably, as each is based on different frameworks and priorities. This study adopted the WHO's dimensions of livability: convenience, amenity, health, and safety, while the city focused on four outcome areas: promoting the social environment, improving environmental quality, upgrading the built environment, and enhancing good governance. These distinct frameworks reflect different priorities which may influence how livability is interpreted and measured.

The results of this study reveal the livability conditions of settlement areas and highlight the influence of land use allocation. In the formulation of the CLUP, it is recommended that residential zones should be allocated within walking distance of commercial, institutional, and park and recreation areas to enhance overall livability.

Given the open-source nature of the data obtained in this study, the urban livability assessment framework is replicable and scalable. It enables scholars, urban planners, and policy makers to measure urban livability using the same framework in other cities or wider scopes of interest. Thus, the framework is useful for evidence-based planning and policy formulation in diverse geographic and socio-economic contexts.

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