

Socio-Spatial Injustice and Planning Paralysis: True Service Accessibility and Land Management Failure in Rapidly Urbanizing Buea, Cameroon

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Abstract

Sustainable urban development is profoundly challenged by socio-spatial inequality that systematically disadvantages vulnerable groups across geographical space, directly undermining the Right to the City. Addressing this is critical for achieving SDG 11, yet rapid Sub Saharan African urbanization continuously generates spatial disparities. Using Buea, Cameroon, this study sought to: (1) assess the spatial distribution and multi-dimensional accessibility of healthcare and security services; (2) quantify the resulting inequalities and their implications for population well-being; and (3) analyze the governance policy failures perpetuating this injustice. We employed a robust mixed-methods approach. GIS-based analysis established nominal access metrics. The legal framework was analyzed via thematic content analysis, while the causes of ineffective enactment were explored through thematic analysis of semi-structured interviews. A stratified household survey then quantified the impacts, using Chi-square tests (χ^2) to compare service outcomes between settlements, triangulating legal deficit, governance failure, and household experience. Nominal proximity was misleading proxy for true access. While marginalized areas were within a distance norm (400m-800m), the true barrier lies in infrastructural decay and planning failure. Sectoral health and security laws were disconnected from spatial planning mandates, creating a legal vacuum. This governance failure was evident as emergency vehicle access dropped from 97% in planned areas to 45% in unplanned zones ($\chi^2=p<0.041$), and average travel time to health centers escalated from 18 minutes to a prohibitive 70 minutes. Political interference was the primary mechanisms preventing law enforcement; ensuring spatial inequality was an enforced outcome of planning paralysis. Hence, spatial inequality in Buea was not merely a technical problem of distance but a direct manifestation of socio-spatial injustice. The projected population dynamics will escalate this crisis by 2030, fundamentally undermining the core tenets of SDG 11. This study proposed shifting to a harmonized, needs-based planning approach that emphasized true access policies, infrastructure development and institutional reform.

Keywords: Socio-Spatial Inequality, Land Use Governance Failure, True Service Accessibility, Urban Sustainability, SSA.

1. Introduction

Spatial inequality is the unjust, heterogeneous distribution of resources and essential services, including healthcare, social welfare, public infrastructure, and household income that systematically advantages certain social groups while disadvantaging others (residents of peripheral informal settlements, internally displaced persons (IDPs), women, and children) across geographical space [1, 2, 3]. This phenomenon is not merely a technical problem of distance or concentration, but a reflection of historical and current social, economic, and political power dynamics that result in socio-spatial injustice [4, 5]. It can be quantified using metrics like proximity and clustering, but it must be understood through the lens of equity and fairness in access to the "Right to the City" and essential human capabilities [6]. This phrase, popularized by Henri Lefebvre in 1968 (*Le Droit à la Ville*), is a cornerstone of critical urban planning and procedural justice. It asserts that all inhabitants have a right to use, occupy, and participate in the

shaping of urban space, regardless of their social or economic status [7]. While not a direct component of procedural justice itself, the concept underpins demands for greater democratic access to urban decision-making, which is a core tenet of procedural justice [8].

In the context of developing nations, spatial disparities are often pronounced, manifesting as significant urban-rural divides, inter-regional disparities, and intra-regional variations between socioeconomically advantaged and disadvantaged areas [9, 10]. These spatial inequalities are inextricably linked to health and social inequities, directly influencing population health outcomes and undermining the achievement of sustainable development goals. A comprehensive, spatially explicit analysis of the scale, characteristics, and temporal trends of these disparities is essential for the development and implementation of evidence-based policies aimed at mitigating disease morbidity and mortality and fostering equitable, safe, inclusive, and sustainable development [11].

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Spatial inequality in social service delivery remains a critical obstacle to sustainable urban planning in developing countries, undermining the targeted goals of SDG 11, which focuses on making cities and human settlements inclusive, safe, resilient, and sustainable [1,12]. SDG 11, particularly targets 11.1, 11.2, 11.3, and 11a, establishes a clear mandate to eliminate spatial inequality by guaranteeing universal access to basic services (housing, healthcare, security), safe transport, and inclusive planning. This global framework explicitly recognizes the need to strengthen planning to connect settlements sustainably in order to promote sustainable urban development [13]. However, inaccessibility, poor road networks and transport systems, fragmented planning, and discriminatory service distribution continue to reinforce inequality across different geographical areas, directly contradicting the spirit of Goal 11[14].

While urbanization in SSA, including Cameroon, presents opportunities for sustainable urban development, the persistent challenge of inadequate service provision continues to impact fundamental human rights [15]. According to [16], over 60% of the African population currently resides in cities. Thus, urbanization has emerged as a significant land use trend in the 21st century, shaping various socioeconomic, political, human, infrastructural, and environmental changes [17,18]. Hence, urban planners must face the challenges of spatial justice to harness the potential for sustainable urban development that meet the needs of the rapidly expanding population in a more sustainable, safe, and inclusive manner[19,20,10].

Existing research has documented the widespread socio-spatial disparities, noting their correlation with adverse outcomes such as increased maternal mortality, traffic congestion, insecurity, limited accessibility, high crime rates, pollution, and the proliferation of slums[21,22,23]. Specifically, [24, 25,26] offered valuable insights into understanding healthcare access inequality phenomena, highlighting their socioeconomic status, insurance coverage, and geographical location, historical and cultural barriers as factors precipitating these disparities. [20, 27] further observed high-income households have a higher potential of accessing basic social services while practicing preventive healthcare measures than low-income households. [23, 22] all noted that one major issue of healthcare and security accessibility in developing countries is shortages of workers, which is made worse by imbalances in the workforce. According to [20, 22], transport mobility barriers often hinder healthcare access in rural areas and low-income settlements. However, many studies present broad overviews and often fail to provide detailed localized analysis of spatial inequality in access to social services.

These studies often suffer from a scale mismatch, often using aggregated national or regional data that masks deep intra-urban disparities, thus failing to capture the lived experience of inequality at the neighborhood level. The study addresses this by employing a micro-level spatial analysis to precisely map the location and severity of health and security issues, shifting the focus from statistical averages to individual vulnerability. Furthermore, unlike studies relying on static data, this research addresses the time-sensitive trend gap by comparing current (2024) service delivery against decadal trends and future projections (2030), focusing on the specific impacts of recent in-migration patterns to provide novel insights into the challenges of rapidly urbanizing African cities. This level of granular, time-bound analysis provides evidence-based, time-critical data directly actionable for urban planning.

This study departs from these general trends by focusing specifically on Buea, a rapidly growing urban center in Cameroon's South West Region, as a critical case study, which has experienced a recent surge in in-migration. Buea experiences an annual growth rate of 5.28%, annually, as against the National Economic Growth Rate of 4.8% [28], much higher in the peri-urban settlements (42%) in 2020 due to the socio-political crisis in other parts of Cameroon. In Buea, the major factor of urbanization dynamics is forced migration with more than 70% of the migrants being youths who are unskilled, an area characterized by limited industries to absorb the fast-growing urban population [29, 30]. This demographic shift presents a critical imperative to establish current patterns of service delivery due to increasing pressure on existing resources (which are insufficient) and often characterized by acute poverty, pollution, disease proliferation, among others, due to insufficient policy and urban planning policy implementation.

The study, therefore, offers a powerful framework for extending theories of spatial justice into the realm of practical urban policy, particularly in the context of the Global South. It operationalizes the theory of Locational Injustice by moving David Harvey's critique from abstract theory to quantifiable policy prescription, demonstrating that the service deficit in peripheral zones is a measurable output of structurally uneven development. Crucially, the comparison across the security and healthcare sectors reveals that structural barriers are the primary driver of inequity, demanding a unified, integrated approach to land-use planning. However, the general challenges of achieving urban sustainability in the Global South are acutely manifested in Cameroon's urban centers, positioning Buea as a critical and illustrative case study for examining the failures of spatial planning and service equity. As a rapidly expanding city, Buea grapples with endemic planning deficiencies and social service deprivations [30, 31]. These structural deficits, which contributed to a broader governance challenge, had demonstrably failed to meet the Millennium Development Goals (MDGs)[32, 33], raising serious concerns that achieving the current global mandate of SDG 11 will also be severely challenging [34].

Despite efforts by municipal and central government stakeholders, a significant gap persists in implementing comprehensive, effective urban planning strategies that genuinely address spatial inequality. Therefore, this study uses the context of Buea to move beyond generalized claims of failure. We focus on how the specific mechanisms of spatial land planning and governance at the micro-level—specifically concerning the provision of healthcare and security services—are failing to ensure equitable access and the overall well-being of the urban population. This study attempted to (1) assess the spatial distribution, accessibility, and resulting inequalities of healthcare and security services within Buea, (2) examine the implications of these inequalities on the well-being of the population, and (3) analyze the planning policies that contribute to or mitigate these spatial inequalities and their implications for equitable and sustainable urban development. The findings from Buea will offer essential, empirically-grounded insights necessary for developing effective city management strategies aimed at social services sustainability and a context-specific African Urban Planning Model where resource planning is dictated by in-migration patterns and interventions are evidence-based, spatially targeted, and functionally integrated.

2. Theoretical Review

Spatial justice, a relatively recent concept often associated with David Harvey and Edward Soja, was adopted for this study. The theory argues that spatial inequality is a product of uneven development, a socio-political process driven by the dynamics of capitalism, rather than a natural or accidental phenomenon [35, 36]. This approach emphasizes that space is not a neutral, physical container but a social construct shaped by economic and political forces that create and maintain inequalities. Through his dialectical framework, Harvey connects spatial justice to the inherent paradoxes of capitalist production and accumulation, highlighting how unequal distribution of resources and opportunities across space is a vital feature of the system [37].

The key aspects of this theory include space as a social construct, where Harvey challenges the idea of space as a mere backdrop to social and economic activity. Instead, he posits that space itself is a product of human activity and power relations. Looking at the uneven development aspect, Harvey argues that capitalist accumulation inherently leads to uneven geographical development, creating disparities in wealth, resources, and power between different places [37]. The "Spatial Fix" aspects of the theory focus on how to manage crises of over-accumulation as capitalism seeks spatial fixes by expanding into new territories, creating new markets, and restructuring space to absorb surplus capital. This process further exacerbates uneven development. His dialectical relationship symbolically states that there is a dialectical relationship between space, justice, and injustice. Justice and injustice are manifest in the very process of specialization, and transforming space is a means to fight against injustice. His focus on capitalism shows that the theory was rooted in a materialist analysis of capitalism, viewing spatial inequalities as a direct consequence of the system's drive for profit and endless accumulation [38].

This theory has significant implications for spatial justice as it challenges positivism, confronting it upfront, especially the traditional geographical approaches that often ignore social justice issues and the contradictions inherent in economic growth. It also challenges the activist project. By this spatial justice, in Harvey's view, was not a static ideal but an active process of changing the spatial structure of society to achieve greater equity for the most disadvantaged [35, 36]. The theory challenges the current understanding of urban inequality, thus providing a framework on how urban spaces are shaped by political decisions, policies, economic forces, and social power dynamics, leading to specific forms of injustice (Figure 1).

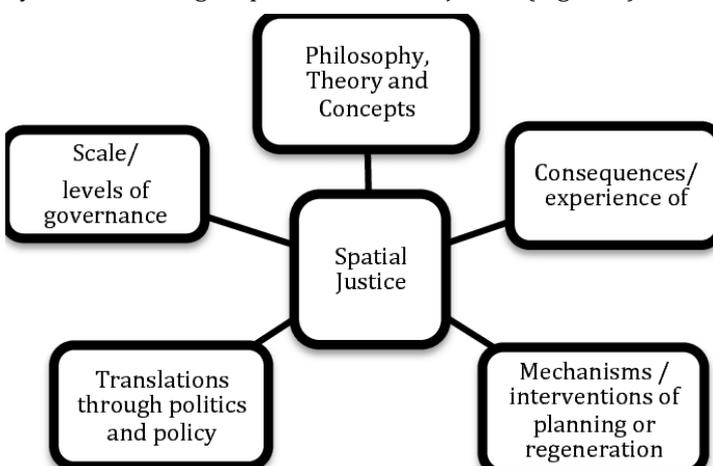


Figure 1: Proposed framework for components of 'spatial justice'
Source: Adapted from [39]

Rapid, unprecedented urbanization across SSA is largely accommodated by informal settlements and illegal land subdivisions, rather than planned expansion. Literature defines this as a process where urban growth occurs outside formal state regulatory frameworks, particularly concerning land tenure, zoning, and infrastructure provision [40]. This informal process generates specific, persistent spatial inequities and injustice. Informal developments bypass regulations, while ambiguous or insecure land tenure in informal areas disincentivizes both municipal governments and private investors from dedicating resources for essential public services (healthcare posts and security facilities) and upgrading basic infrastructure (roads, water lines), thereby reinforcing marginalization. The failure to manage urban space is often rooted in planning legislation that is either obsolete, inappropriate for the local context, or structurally inadequate to guide dynamic growth, often characterized by outdated plans and disconnection between various sector plans. Even where regulations exist, weak institutional structures and governance challenges prevent effective enactment, translating legal principles into de facto spatial injustice in terms of weak enforcement paralysis, corruption, and weak citizen participation.

In Buea, the concentration of high-quality services in the colonial administrative core and the deficit in peripheral, high-growth, or rural-urban fringe areas characterized by a rapid influx of migrants is evidence of this structural bias. The allocation of hospitals and police stations is a function of historical and political power, often prioritizing areas with higher tax bases, historical background, or political influence, thereby perpetuating locational injustice for marginalized communities. This is the stakeholders' failure to meet critical service delivery standards due to physical geography, internal planning, and poor infrastructure. The goal of future land use planning in Buea must therefore be to transition from a historically centralized, deficit-based model to a decentralized, equity-driven model prioritizing underserved areas to correct political, social, and historical bias, not merely follow population growth. The application of this theory will also support a shift in land-use planning and governance to legally enforce the equal distribution of essential services.

3. Methodology

3.1 Study Area

Buea is located in Fako Division of the South West Region of Cameroon (Figure 2) on the Eastern slopes of Mount Fako, 210km from the West Coast tourist city of Limbe. As a multiethnic urban center, Buea is located between Latitude 4012' to 4031' North of the Equator and Longitude 909' to 9012' East of the Greenwich Meridian. Buea has a mean annual rainfall exceeding 2815mm, annual mean temperature of 18.6°C and monthly mean temperatures of 19.7°C [24]. It has a population estimated at about 47,300 people with an annual growth rate of 4.85% according to the 2005 population census with a density of 52,76% spread over a surface area of approximately 870km². In 1976 the official population of Buea was 22,948 inhabitants. In 2008, it had increase to 141,111 inhabitants and today 2023, the urban dwellers stood at 270469 inhabitants [28]. This was for the entire municipality but that of the urban and peri-urban spaces was estimated at 80,157 inhabitants. The increase in population has been rapid at an exponential rate which is today mounting pressure on social services. With this situation, there has been a spatial injustice. Amidst these dynamics, a study to uncover the pattern of inequality was needed.

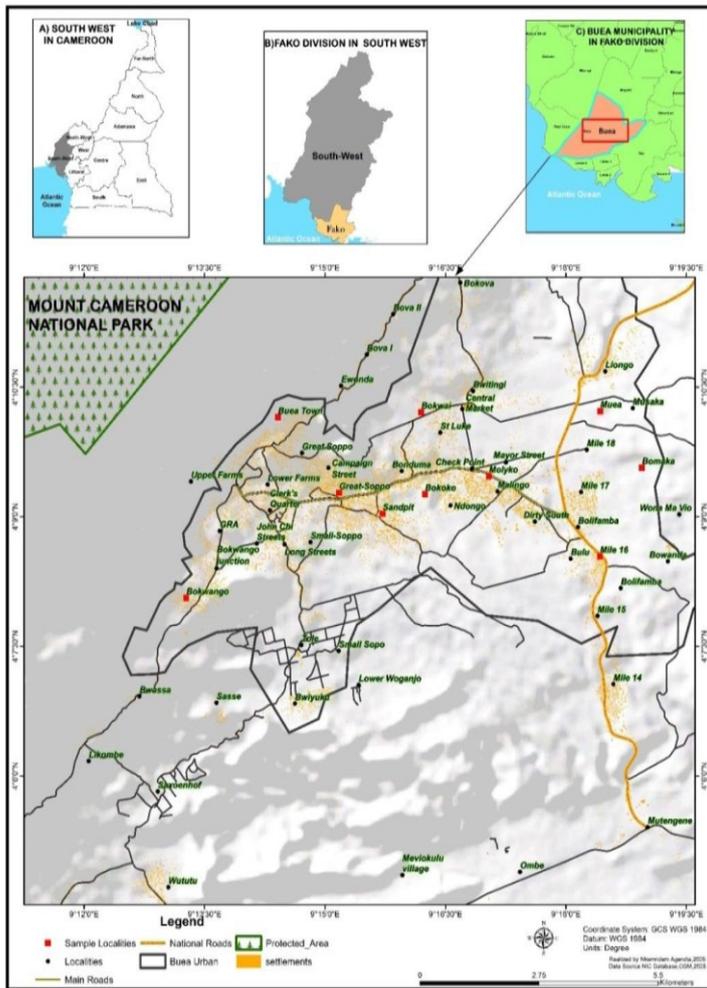


Figure 2: Layout of Buea in Fako Division, South West Region of Cameroon
Source: Adapted from the Administrative Map of Buea (2016)

2.2 Research Design

This research utilized a mixed-methods cross-sectional design structured around the principle of triangulation, integrating four distinct yet complementary components to ensure a comprehensive understanding of socio-spatial inequality. GIS was employed to map the precise locations of healthcare and security service points against population distribution and

existing land use, quantifying nominal accessibility and identifying spatially marginalized zones. A stratified, cross-sectional survey was administered to capture residents' experiences and perceptions of service delivery, measuring the true impact of accessibility barriers on well-being and establishing quantitative differences between neighbourhoods. Qualitative data were collected through interviews with key stakeholders to understand the institutional and political factors driving the ineffective enactment of planning laws and contributing to spatial injustice. A systematic content analysis of central legal texts and municipal documents was conducted to establish the mandated standards for service provision and identify critical regulatory gaps and policy contradictions. This design allowed the study to move beyond simple distance metrics, linking legal and governance failures directly to measurable spatial inequalities and detrimental well-being outcomes.

2.3 Data Collection Sources and Procedures, and Sampling

Data were triangulated from three primary sources, including 2024 population estimates, 2030 projections, and facility counts for 31 Security Facilities (SFs) and 24 Health Facilities (HFs) sourced from municipal and relevant sectoral offices. The digitized 2024 road network of Buea was used as the foundational Network Dataset. Precise coordinates (POI) for all facilities were captured via GPS during fieldwork. Crime incident data (categorized by severity) for the preceding 12 months was obtained from relevant security agencies. A systematic review of municipal and urban planning documents and sectoral policy papers from the past decade was used to provide a longitudinal context and insight into planning mandates. To ensure the micro-level analysis accurately reflected the spatial heterogeneity of service delivery, a Stratified Sampling approach was implemented allowing for a direct statistical comparison of the differential impacts of urban governance (or the lack thereof) on population wellbeing and health access across planned and unplanned areas. The 12 distinct neighbourhoods served as the non-overlapping strata for the sampling frame. The total sample size of 215 households was then allocated across these strata using Proportional Allocation based on the 2024 population size of each neighbourhood (Table 1).

Table 1: Administration of questionnaires

Stratum Type	Neighbourhood	2024 Population Statistics	Sample Size	Sampling fraction %
Planned/ Centralised Areas	Molyko	9545	29	13.5
	Great Soppo	7719	17	7.9
	Buea Town	15711	34	15.8
	GRA	2270	8	3.7
Unplanned/ Peri-Urban Area	Sandpit	6731	18	8.3
	Bokoko Biaka	1162	7	3.2
	Bokwai	1050	12	5.6
	Bokwango	7062	17	7.9
	Muea	8701	26	12
	Bomaka	1086	18	8.7
	Mile 16	9348	23	10.7
	Bokova	327	6	2.7
	Total	80,157	215	100

Source: Demographic Data of MINSANTE (2024)

This method ensured that while every neighbourhood (stratum) was represented for spatial comparison (preventing the accidental exclusion of smaller communities), the sample size drawn from each neighbourhood was proportional to its actual population size. This approach was critical for maintaining the statistical validity of neighbourhood-specific resource ratios while guaranteeing comprehensive geographical coverage necessary for the GIS-based functional accessibility analysis. Stratified sampling ensured that disparities in low-population areas were not overlooked due to large-population areas dominating the sample. It was statistically ideal in comparing the socioeconomic characteristics of the strata (neighbourhoods) themselves, which was exactly what the study does with its ranking and disparity analysis.

Using proportional allocation ensured that the final aggregated results remained an accurate reflection of the entire study area's population, balancing the need for deep local insight with overall representativeness. Based on this, a total of twelve (12) neighbourhoods categorized as planned/central areas based on formal planning, registered land tenure, better utility/road infrastructure, and proximity to major government, security, and healthcare facilities and unplanned/peri-urban areas classified based on informal/spontaneous settlements, poor road accessibility, inadequate water/sanitation (WaSH) facilities, and higher vulnerability to public health crises due to spatial exclusion was administered to the respondents. This classification was done based on [41] standards which identifies unplanned human settlements as areas prone to sprawl, inefficient land use, poor connectivity, and a lack of adequate municipal services.

The total required sample size for this study was calculated using the Epi Info 6.04d statistical package to ensure statistical validity and a reliable confidence level for generalizing the findings to the respective strata using the formula:

$$n_0 = \frac{Z^2 \times P(1 - P)}{E^2}$$

Where:

n_0 = Uncorrected sample size

Z = Z-score (dictated by the desired Confidence Level)

P = Expected proportion/prevalence (a conservative estimate)

E = Desired margin of error (precision)

Total Population (N) \approx 80,157 (Total 2024 Population)

Expected Frequency (P) 50% (or 0.5)

Confidence Level (C.L.) 95%

Acceptable Margin of Error (E) 6.5% (or 0.065)

The Epi Info was used to calculate the necessary sample size for the study to be 215 respondents, which was deemed sufficient to represent the total population with 95% confidence and a \pm 6.5% margin of error. This total sample size was subsequently used to administer the open and closed ended questionnaire to households who have lived for over 20 years facing critical social injustice to ensure accurate micro-level representation.

A structured questionnaire was used to collect quantitative data on perceived access to healthcare units, frequency of access, cost, and distance to nearest reliable source, type of security facility, frequency, travel time and knowledge of local planning regulations, experience with planning officials and emergency vehicle access. Trained enumerators were used to administer the questionnaire to the selected households.

Thematic analysis was used on qualitative data to understand the institutional and political factors behind the ineffective enactment of planning laws, focusing on governance challenges, bureaucratic processes, and corruption that perpetuate spatial inequality in service provision. Purposive sampling was used to target 15 key stakeholders for informal interviews, including town planners, local representatives of municipal and government agencies and civil society advocates knowledgeable on urban governance. Semi-structured interviews used a detailed guide with questions on political interference, funding gaps, and the direct causes of illegal/haphazard development. The interviews were designed to move beyond policy text and uncover the institutional and political factors that explain the ineffective enactment of spatial planning laws. Key insights from the thematic analysis were drawn from the following critical interviews, which provided the necessary qualitative evidence to support the findings on governance failure and spatial injustice.

The foundation of the spatial analysis was built upon georeferenced point data for all essential service infrastructure. The geographical coordinates (GPS waypoints) of all public and registered private healthcare facilities (hospitals, health centers and clinics) and security infrastructure (police stations, gendarmerie posts) operating within the 12 administrative neighborhoods of Buea were systematically collected using a high-precision GPS device. This point data was layered onto a base map, which included official administrative boundaries, and mapped road networks. This established the geographical context necessary for calculating accessibility metrics.

The qualitative component also established the legal baseline and identified institutional contradictions through systematic document collection. The Core documents collected included the Town Planning Law No. 2004/003 and relevant Decentralization Laws (2004/17, 2019/024) governing municipal competencies in planning and service delivery. Key local documents reviewed were the Buea Communal Development Plan (CDP), the Master Plan, various reports from the Buea council and line ministries (MINHDU and MINSANTE) detailing resource allocation and infrastructure projects. The review specifically sought to identify explicit service standards, zoning regulations, mechanisms for citizen participation, and contradictory clauses concerning enforcement authority between the local Council and the central government.

2.4 Data Analysis and Presentations

All data obtained through inventory using questionnaire were typed in Microsoft excel and saved in CSV (Common Delimited) format for analysis. Subsequently, the spreadsheets were downloaded and exported to the Statistical Package for Social Sciences (SPSS Version 25.0). Quantitative data was analyzed using Descriptive Statistics (frequencies, percentages, means) to profile service access and Inferential Statistics (Chi Square and Spearman's Rank Correlation) to test for significant differences in service provision between the planned and unplanned neighborhoods. Population and projections data from the Sub-divisional Office Buea including security post, health facilities and staff counts was used to derive standardized metrics for cross-neighborhood comparison. The between these resources and population ratios quantify accessibility, representing the number of people served by one unit of resource. A lower ratio indicated better coverage. Hence, HF ratio measured the number of residents per health facility while the specialized workers ratio was used to measure the number of residents per specialized workers. The formula used is presented as follows:

$$\text{Population-to-Resource Ratio} = \frac{\text{Population}}{\text{Number of Resources}}$$

Significantly, neighbourhoods were ranked based on the 2024 Ratios (Rank 1st = best coverage/lowest ratio). The ranked Difference (d) was used to check for alignment with another variable. The d zero (0) aligned with resource distribution, d negative aligned with specialized workers which are disproportionately concentrated in areas with relatively poor facility coverage and d positive aligned with facilities that are disproportionately present in areas with a low number of specialized workers. The Ranked Difference Squared (d^2) was used to compute the overall non-concordance (Σd^2) to determine the degree of spatial inequity in resource allocation. The calculation for the Mean Linear Distance was performed using the weighted average method for grouped data derived from the Household Survey responses.

This method used the frequency of responses in each range category to estimate the true mean distance for each neighborhood. The Mean Linear Distance ($X̄$) for each neighborhood was calculated using the following formula:

$$X̄ = \frac{\sum(f \times m)}{N}$$

Where:

$X̄$ = Mean Linear Distance (in meters).

f = Frequency (number of households) in each distance range.

m = Midpoint of each distance range.

N = Total sample size (total frequency) for the neighborhood.

Since, data from field survey provided distance ranges (200m–400m) rather than exact distance measurements, a midpoint was assigned to each category. Specific assumptions were made for the open-ended categories to complete the calculation. The following midpoints were assigned to the distance categories to perform the calculation (Table 2).

Table 2: Midpoint Assumptions for Service Delivery

Distance	Range Midpoint (m)	Assumption
<200m	100m	Center of 0m–200m
200m–400m	300m	Center of the range
400m–600m	500m	Center of the range
600m–800m	700m	Center of the range
800m–1000m	900m	Center of the range
1km+ or 1km	1100m	Assumed center of 1000m–1200m
600m+	700m	Assumed center of 600m–800m

Source: Fieldwork, 2024

While network-based analysis is generally superior for measuring actual travel time, using linear distance is justifiable for this study because planning laws are fundamentally based on the principle that services should be located within a certain maximum radius or proximity to populations irrespective of which, the basic planning principles are being violated. Linear distance is a uniform, measurable metric that is unaffected by constantly changing variables like traffic flow, road closures, or the seasonal deterioration of unpaved roads. It offered a consistent, objective baseline for comparison across all neighborhoods, regardless of how chaotic the enforcement failure has made the local street network. It was also used for triangulation purposes and because of limitation of GIS data for the tertiary and informal street networks in rapidly changing, unplanned settlements which is more expensive and time consuming.

The spearman's rank-order correlation coefficient (ρ) was used to test the statistical relationship between the observed spatial inequalities and population well-being outcomes and their level of significant. This non-parametric test was selected because it assesses the relationship between neighbourhood population size and the number of existing service units (healthcare/security) to determine if service distribution aligned with current demographic need assess the relationship between distance/travel time to the nearest service center and various household well-being indicators. The resultant Spearman's rho (ρ) coefficient described the strength and direction of the relationship, while the associated p-value set at $\alpha < 0.05$ to determined statistical significance.

Semi-structured key informal interviews were conducted with 15 administrative officials, service providers (facility directors), and community leaders to elicit specialized knowledge on resource allocation logic and operational constraints and the socio-political, and historical factors driving spatial inequality. Qualitative data were transcribed and analyzed using thematic analysis to identify recurring themes related to service perception and equity.

Interview recordings were transcribed verbatim and reviewed and the six-step process of thematic analysis was applied [42] which including generating initial codes from the data, grouping codes into broader, significant themes, refining the themes to accurately reflect the data. The themes explained the 'why' behind the legal weaknesses identified and set the stage for interpreting the household data.

Crime intensity was calculated using density mapping techniques that convert discrete crime incidents (points on a map) into a continuous surface showing concentration. All crime reports were geocoded, converting the address or location description into precise (x, and y) coordinates on the map. This was used to creates a point layer for all incidents. To reflect severity, the analysis used weighted density. The Kernel Density Estimation (KDE) tool was the standard GIS method for measuring crime intensity. It created a smooth, continuous raster surface representing the concentration of incidents across Buea. KDE calculates density by centering a smooth, curved surface (kernel) over each crime point. The value of the resulting cell was highest at the center of the kernel and diminishes with distance. Overlapping kernels were summed to create the final density surface. A raster map where each cell has a numerical value representing the number of crime incidents (or weighted incidents) per unit area (per square kilometer) was used. The continuous KDE output was classified into discrete tiers (high, moderate and low) using a fixed threshold method with definitions. For instance high crime intensity tier was based on a density range from 10%-15% of density value (statistically significant hotspot, followed by moderate tier (30-40%) density value and low tier (50-60%) corresponding to areas with statistically few crime incidents.

Content analysis was used to examine the official legal and policy framework to understand the explicit provisions for spatial planning, service delivery, and the mechanisms for enforcement. This served as the baseline for assessing the gaps between policy and practice. The data sources and scope exploited legal texts including the Town Planning Law No. 2004/003 and its subsequent decrees and Decentralization laws affecting municipal service provision, the Buea CDP, the Master Plan and Land Use Plan (LUP) and various administrative reports of councils and government related ministries to identify designated service areas, zoning regulations, and proposed infrastructure projects. These relevant documents were systematically collected and categorized. There were coded into keywords, phrases, and sentences related to spatial planning, service standards, enforcement mechanisms, and equity/spatial justice principles. The analysis quantify the presence and frequency of these codes and, more importantly, qualitatively interpret the intent of the laws regarding service delivery and spatial equity which shows contradictory clauses and limited enforcement powers.

Most outcomes of the analyses were presented using tables, descriptive statistics, and advanced geospatial visualizations to clearly convey the degree of spatial inequality and the functional failure of service delivery. Summary tables presented the calculated population resource ratio, rank disparity (d) per neighborhood, the average response time (in minutes) for each neighborhood, linking static ratios to dynamic accessibility failure and the current 2024 ratios alongside projected 2030 ratios to illustrate future strain on services. Spatial results were presented using thematic maps generated in ArcGIS, offering the most compelling evidence of spatial inequity especially in the critical zones where high crime spatially concurred with poor accessibility.

2.5 Ethical Considerations

Ethically, there was a strict operation of inform consent during the data collection process. The study protocol was reviewed and approved by the University of Buea Review Board and ethical committee. Confidentiality and anonymity were maintained throughout the study; identifying information was removed from all transcripts, and precise geographic coordinates were aggregated to the neighborhood level for public reporting. All participation was voluntary.

2.6 Limitations of the Study

The findings of this study must be interpreted within the context of the following limitations. The crime intensity analysis is dependent on the completeness and accuracy of official police reporting. Underreporting of certain crime categories may lead to an underestimation of the actual resource strain in some areas. The study provides a detailed snapshot of 2024. While projections to 2030 were included, the cross-sectional design does not capture the continuous, dynamic evolution of resource allocation decisions or infrastructure improvements between the time of data collection and future policy implementation. The population resource ratios and GIS models measure the accessibility and quantity of facilities, but do not directly assess the quality of the services provided within those facilities.

3. Results

3.1 Spatial Distribution, Accessibility, and Inequality of Land-Based Services

3.1.1 Spatial Equity in Healthcare Service Delivery

This section provided results on the spatial equity in healthcare services in Buea. It specifically identified the diverse categories of health facilities and the extent to which the population can access them when needed considering the minimum travel time, distance and availability of transportation services for their improved wellbeing. This section further involved mapping the healthcare facilities and analyzing their relationships with the current demographics including projections.

Categories and Spatial Distribution of Healthcare Facilities

Healthcare facilities are the backbone of any healthcare system, providing essential medical services to individuals and the community. The respondents perceived views on the categories of healthcare facilities was dominated by primary healthcare deliveries provided by the government, religious and non-governmental agencies as indicated by 76.47% of the respondents, followed by secondary healthcare facilities (14.70%), tertiary healthcare facilities (5.89%) and the least others such as birth attendance centers, pharmacies, drug shops with a proportion of only 2.94% of the sampled respondents. From table 3, the reasons for the high dominance of primary healthcare provision in Buea were due to the first point of contact to the population and patients suffering from common diseases like malaria, typhoid, 'catarrh' and for other first aid treatment. These facilities provide basic medical services and are close to the population and more in number than secondary healthcare facilities. These types of healthcare facilities also required limited investment from the government since hosting communities provide them and equipped them with the required physical facilities such as structures and accommodations for any member of staff including patience from far and wide that is posted there or that came for medical attention respectively. Conversely, the tertiary healthcare facilities are limited as they provide only complex healthcare

services for patients requiring specialized treatment. The members of staff in these different health categories are usually one or two people that are often posted by the government on permanent or contract terms (Medical Doctor (MD), General Nurse (GN), Medical Record Officer (MRO) or probably Medical Laboratory Technician (MLT). Furthermore, the analysis of field data revealed that Buea has a PIM, 9 Integrated Health Centers, 4 CMA, 19 private healthcare services and one Reference Hospital Annex (Figure 3).

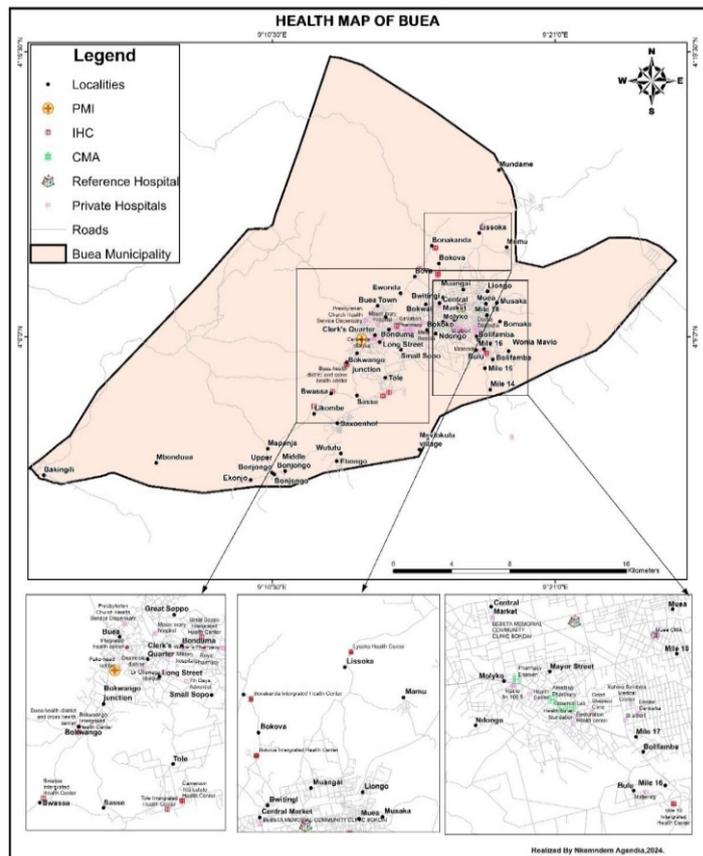


Figure 3: Spatial distribution of healthcare facilities in Buea
Source: Adapted from the Administrative Map of Cameroon, 2016; Fieldwork 2024

Although, Buea has only one Regional Hospital with 08 District Health Units spread across planned and unplanned neighbourhoods, there are other affiliated government healthcare centers like the Police health center in Clerks quarter, the University of Buea Healthcare Unit and Gendarmerie Health Units in Great Soppo with provide diverse services to the local communities including workers and students at cost free. The University of Buea also host the Faculty of Health Science (FHS) which acts a growth pole for many student influx into Buea for specialize training in medicine, pharmacies, midwifery and dentists. To achieved these students often engage in skill and practical training at the regional hospital under the supervision of the regional delegation of public health. Also, complementing the public healthcare systems were the private healthcare centers exist such as the Solidarity Clinic, Biaka Health Institute in Molyko, 7 Days Adventist in Soppo and Reach Out Foundation Hospitals among others own by individuals and organizations. These services may also provide specialized training for students in various domains of healthcare provision thus promoting increase wellbeing and increase lifespan opportunities. However, results revealed that some areas have limited access to healthcare facilities, while others have better coverage due to political influence, government priorities, population densities, settlement types, employment status,

level of education and household income.

Quantitative Accessibility of Health Facilities

The mean linear distances quantify the average straight-line proximity of households to the nearest health center in meters and kilometers and results presented on Table 3.

Table 3: Perceived frequency of Time and Distance and Mean Linear Distance to health services

Neighbourhoods	Time	Frequency (%)	Distance	Frequency (%)	Mean Linear Distance (m)	Mean Linear Distance (km)
Molyko	<20minutes	12(41.38)	<200m	14 (48.27)	251.72	0.25
	20mins-40min	11 (37.93)	200m-400m	8 (27.59)		
	40mins-1 hour+	6 (20.69)	400m-600m	7 (24.14)		
Soppo	<20minutes	6 (35.29)	<200m	4 (23.53)	412.50	0.41
	20min-40 mins	5 (29.41)	200m-400m	3 (17.65)		
	40mins -1 hour	3 (4.23)	400m-600m	6 (35.29)		
	1.5 hours -2 hours	2 (11.76)	600m-800m	2 (11.76)		
	2hours+	1 (5.88)	800m-1000m	1 (5.88)		
Buea Town	<20minutes	14 (41.18)	<200m	12 (40)	300.00	0.30
	20mins -40 mins	10 (29.41)	200m-400m	9 (30)		
	40mins - 1 hours	3 (8.82)	400m-600m	6 (20)		
	1hours+	3 (8.82)	600m-800m	3 (10)		
Muea	<20minutes	3 (11.54)	<200m	1 (4.76)	604.76	0.60
	20min-40 mins	2 (7.69)	200m-400m	3 (14.28)		
	40mins -1 hour	6 (23.08)	400m-600m	5 (23.81)		
	1hour 1.5 hours	3 (11.54)	600m-800m	9 (42.86)		
	1.5 hours -2 hours	10 (38.46)	800m-1000m	2 (9.52)		
	2hours+	2 (7.69)	1km+	1(4.76)		
Mile 16	<20minutes	2 (8.69)	<200m	2 (8.0)	748.00	0.75
	20min-40 mins	4 (17.39)	200m-400m	3 (12)		
	40mins -1 hour	5 (21.74)	400m-600m	1(4)		
	1hour 1.5 hours	7 (30.43)	600m-800m	6 (24)		
	1.5 hours -2 hours	4 (17.39)	800m-1000m	7 (28)		
	2hours+	3 (13.04)	1km	6 (24)		
Bomaka	<20minutes	1 (5.56)	<200m	2 (10)	570.00	0.57
	20min-40 mins	3(16.67)	200m-400m	3(15)		
	40mins -1 hour	2 (11.11)	400m-600m	5 (25)		
	1hour 1.5 hours	3 (16.11)	600m-800m	7 (35)		
	1.5 hours -2 hours	9 (50)	800m-1000m	2 (10)		
	2hours+	2(11.11)	1km	1(5)		
Bokwango	<20minutes	2 (33.33)	<200m	1 (16.67)	500.00	0.50
	20min-40 mins	2(33.33)	200m-400m	1 (16.67)		
	40mins -1 hour	1(16.67)	400m-600m	1(16.67)		
	1hour 1.5 hours	1 (16.67)	600m+	3 (50)		

Source: Fieldwork, 2024

Table 3 showed that the mean linear distance is interpreted as a measure of inequity in service placement (a core planning function), which was then contrasted with the reported travel time to highlight the role of ineffective enactment (governance failure). The results confirmed a clear spatial gradient in service provision in Buea with core advantage neighbourhoods as older or centrally planned areas such as Molyko and Buea Town, demonstrated a high degree of equity in service placement, with average distances of less than 300m. The distances progressively increase towards the peri-urban fringes which are the disadvantaged neighbourhoods. For instance, Mile 16 (0.75 km) has a mean linear distance three times greater than Molyko. This indicated that as Buea expanded, the planning system has failed to reserve and allocate land for services in peripheral areas, causing immediate spatial inequality at the most basic level of accessibility. Molyko has the shortest mean linear distance (0.25 km), representing optimal service placement. However, Table 4 shows 20.69% of Molyko residents still face 40mins–1 hour+ travel times. This discrepancy proved that even where placement is good, enforcement failure (leading to traffic congestion, blocked access, or poor road quality) turns a short distance into a massive temporal barrier. Neighbourhoods like Muea has a moderate linear distance (0.60 km). However, when the linear distance was combined with the effects of non-enforcement (haphazard growth, poor infrastructure), the majority of its residents (70.77% total) face travel times exceeding 40 minutes to access health services. This demonstrated that inequitable placement is severely amplified by the consequences of non-enforcement, resulting in critical access failure for health and security services.

Population-Healthcare facility Ratio Analysis

The relationships between healthcare facilities and population including projections were assessed to examine the crucial role of health outcomes on the population wellbeing and sustainable urban development. Table 4 shows spatial relationship between healthcare facilities and specialized workers in relation to population sizes of 2024 including 2030 projection.

Table 4: Spatial variations in primary health care facilities, specialized workers and projections

Neighbourhood	No. of HFs	Number of specialized Workers	2024 Population	2030 Population	Ratio of hospital to Population 2024	Ratio of hospital to Population 2030	Ratio Specialized workers to population 2024	Ratio Specialized workers to population 2030	Ranked Specialized workers to population	Ranked hospital to Population	Ranked difference (d)	Ranked difference (d ²)
Molyko	27	3	9545	10922	354:1	406:1	3182:1	3641:1	10 th	10 th	0	0
Soppo	15	4	7719	8832	515:1	589:1	1929:1	2208:1	6 th	6 th	0	0
Buea	5	4	15711	17978	3142:1	3595:1	3142:1	3595:1	9 th	9 th	0	0
GRA	2	4	2270	2597	1135:1	1299:1	568:1	659:1	3 rd	1 st	2	4
Sandpit	2	4	6731	7702	3366:1	3851:1	1683:1	1926:1	5 th	5 th	0	0
Bokoko	3	2	1162	1329	387:1	443:1	581:1	665:1	4 th	2 nd	2	4
Bokwai	4	1	1050	1201	263:1	300:1	1050:1	1201:1	7 th	3 rd	4	16
Bokwang	11	6	7062	8081	643:1	735:1	1177:1	1347:1	8 th	4 th	4	16
Muea	13	6	8701	13389	669:1	1029:1	145:1	223:1	1 st	7 th	-6	36
Bomaka	2	3	1086	7531	543:1	3765:1	362:1	2510:1	2 nd	8 th	-6	36
Mile 16	2	1	9348	10696	4674:1	5348:1	9348:1	10696:1	11 th	11 th	0	0
Bokova	1	0	327	374	327:1	374:1	0	0	12 th	12 th	0	0
Total	31		80,157	90,632	-	-	-	-				112

Source: Sub Divisional Office, Buea 2024, Population, 2030 Projections and Fieldwork, 2024

From Table 4, Mile 16 was the most underserved in both infrastructure and staffing (Rank 11th for both), requiring the highest, immediate, and comprehensive intervention while Bokova (Rank 12th for workers) has a facility but zero specialized workers, rendering its 327:1 HF ratio effectively meaningless for quality care. The Ranked Difference values show a -6d for Muea and Bomaka respectively as specialized workers are highly available (Rank 1st & 2nd) but HFs are relatively scarce (Rank 7th & 8th). Thus, these neighbourhoods have limited primary care access despite good specialized staff numbers, suggesting a few large, staff-heavy centers. Conversely Bokwai and Bokwango have a rank different of 4 (highly positive). This means that the HFs in these areas was relatively abundant (Rank 3rd & 4th) but specialized workers are scarce (Rank 7th & 8th). Hence despite abundant facilities available, essential services offered to the population are scarce due to lack of personnel. Conversely, GRA and Bokova, has a ranked difference values of 2 which means that just like Bkwango and Bokwai health facilities are prioritise over staffing thus the need to assigned more specialized workers to these developing peripheral HFs.

The 2030 projections confirm a worsening of access across nearly all areas due to failure of current planning to keep pace with demographic change for instance, ratios for HFs and workers increase (worsen) across the board, such as Molyko's HF ratio increasing from 354:1 to 406:1. Bomaka's population is projected to multiply sharply (from 1,086 to 7,531). This will cause its HF ratio to drastically deteriorate to 3,765:1 (a seven-fold decrease in accessibility). This is the single most urgent planning requirement to prevent a severe public health access crisis. Mile 16 continues to remains the most resource-deprived area, with its worker ratio exceeding 10,000:1 by 2030 (10,696:1).

3.2 Spatial Equity in Security Service Delivery

This section explores the nature and distribution of security agencies, their spatial accessibility and relationship with demographics including projections.

Categorization and Distribution of Public Security Facilities

The categorization and distribution of public security services plays a crucial role in sustainable urban development. Perceived views on the categories of security facilities were dominated by Police Stations provided by the central government as indicated by 76.47% of the sampled respondents, followed by Gendarmerie National (14.70%), followed by municipal or council police (5.89%) and the least others such as military and

private security companies and vigilante groups within neighbourhoods with a proportion of only 2.94% of respondents. Buea has Four (05) Police Station including Muea, GMI, Central, First District and Molyko, 3 Gendarmerie Units including the special service, legion and Soppo, 01 Military Unit and 05 Security Companies including mobile security patrol stations and vegiligante units making 31 security services with majority located in high income residential areas.

Figure 4 presents the spatial distribution of security posts. The Figure clearly marks the locations of formal security posts. The distribution appears somewhat concentrated in Clerk's Quarter, Long Street, Buea Town area) and along major routes including the specific locations of various types of interventions like destruction, Violation of injunction, Sale of Illicit Drugs, Motor Park, Cyber Criminality, and Gunshots. Thefts were visibly spread across unplanned settlements and highly population and economic concentrated neighbourhoods like Muea, Molyko and Mile 16. Sales of illicit drugs were preponderant across all neighbourhoods. Overall, the overlay of these incidence points with the locations of security posts allows for an assessment of the proximity of security services to areas of high risk.

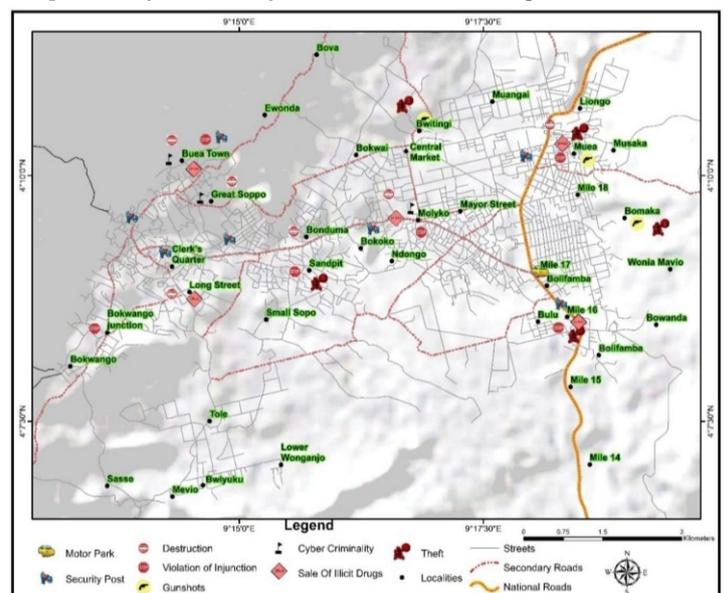


Figure 4: Spatial distribution of public security facilities and the possible interventions Source: Source. Fieldwork, 2024

As seen on Figure 4 majority of the police stations handle investigations, crime matters and ensure public safety, traffic control, and the gendarmerie ensure low enforcement, public order maintenance.

The municipal police assist in controlling traffic flow and maintain order in public places like the Mile 17 Park. Although, the military role is centered on ensuring national security, their role in Buea was justifies following the escalation of the Anglophone crisis where there has been high incidence of crimes, killing and harassment. Private security companies like the Shepard Security and Consultancy International offer services such as guarding for institutions and banks including consultancy services. The intensification of the Anglophone crisis in 2019 have forced vigilante groups especially in peri urban communities to engage in inclusive participation in safety magement through reporting and local intervention. However, political influence, government priorities, population densities, settlement types, employment status, level of education and household level of income continue to influence the distribution of security services.

Quantitative Accessibility of Security Facilities

The security accessibility situations shows great deviation due to distance and travel time. The mean linear distances quantify the average straight-line proximity of households to the nearest police post in meters and kilometers (Table 5).

Table 5: Perceived time and Distance to security services

Neighbourhoods	Time	Frequency (%)	Distance	Frequency (%)	Mean Linear Distance (m)	Mean Linear Distance (km)
Molyko	<20minutes	8 (27.59)	<200m	7 (24.14)	362.07	0.36
	20-40mins	11 (37.93)	200m-400m	6 (20.69)		
	40mins-1 hour+	10 (34.48)	400m-600m	16 (55.17)		
Soppo	<20minutes	2 (11.76)	<200m	2(11.76)	523.53	0.52
	20-40 mins	3 (17.65)	200m-400m	3 (17.65)		
	40mins -1 hour	8 (47.06)	400m-600m	5 (29.41)		
	1.5 -2 hours	3 (17.65)	600m-800m	5 (29.41)		
	2hours+	1 (5.88)	800m-1000m	2 (11.76)		
Buea Town	<20minutes	13 (43.33)	<200m	10 (33.33)	313.33	0.31
	20-40 mins	11 (36.67)	200m-400m	9 (30)		
	40mins - 1 hours	3 (8.82)	400m-600m	10 (33.33)		
	1hours+	3 (8.82)	600m-800m	1 (3.33)		
Muea	<20mins	1 (4.76)	<200m	1 (4.76)	623.81	0.62
	20-40 mins	1 (4.76)	200m-400m	2 (9.52)		
	40mins -1 hour	9 (42.86)	400m-600m	4 (19.05)		
	1hour 1.5 hours	5 (23.81)	600m-800m	12 (51.14)		
	1.5 -2 hours	4 (19.05)	800m-1000m	1 (4.76)		
	2hours+	1 (4.76)	1km+	1(4.76)		
Mile 16	<20mins	1 (4.00)	<200m	1 (4.00)	764.00	0.76
	20min-40 mins	3 (12.00)	200m-400m	2 (8.00)		
	40mins -1 hour	12 (48.00)	400m-600m	3(12.00)		
	1hour 1.5 hours	6 (24.00)	600m-800m	5 (20.00)		
	1.5 -2 hours	2 (8.00)	800m-1000m	10(40.00)		
	2hours+	1 (4.00)	1km+	4 (16.00)		
Bomaka	<20mins	1 (5.00)	<200m	1 (5.00)	680.00	0.68
	20min-40 mins	2(10.00)	200m-400m	2(10.00)		
	40mins -1 hour	4 (20.00)	400m-600m	3 (15.00)		
	1hour 1.5 hours	8 (40.00)	600m-800m	8 (40.00)		
	1.5 -2 hours	3 (15.00)	800m-1000m	4 (20.00)		
	2hours+	2(10.00)	1km	2 (10.00)		
Bokwango	<20mins	2 (33.33)	<200m	1 (16.67)	500.00	0.50
	20min-40 mins	2(33.33)	200m-400m	1 (16.67)		
	40mins -1 hour	1(16.67)	400m-600m	1(16.67)		
	1hour 1.5 hours	1 (16.67)	600m+	3 (50)		

Source: Fieldwork, 2024

As seen in Table 5, the calculated mean linear distances highlight security inequality in accessibility due to poor urban planning. Buea Town (0.31 km) and Molyko (0.36 km) have the shortest mean linear distances to any security post. The average straight-line distance increases significantly in the peri-urban areas, culminating in Mile 16 (0.76 km), which is 2.4 times farther than Buea Town. Molyko has an excellent mean linear distance (0.36 km), suggesting optimal placement of the security post in terms of accessibility. However, Table 7 shows that 34.48% of Molyko residents report 40minutes–1 hour or more to access security services. This large time in Molyko was not due to distance, but to traffic congestion and encroachment on rights-of-way, which are direct consequences of political patronage and failure to enforce building codes. The system fails even where services are well-placed. Muea and Mile 16 suffer from a dual inequality. They have long linear distances (0.62 km and 0.76 km respectively), which is then severely compounded by physical inaccessibility. In Mile 16, the majority of respondents (84%) report delays exceeding 40 minutes. The failure to enforce planned road networks and secure emergency corridors means security vehicles cannot navigate the unplanned terrain.

Population-Security Service Ratio Analysis

The availability of security services plays a crucial role in sustainable urban development. Unfortunately, the results on Table 6 revealed a significant variation on the relationship between security access and population, including projections. Tale 5, examines the spatial equity in healthcare delivery by detailing the distribution of Primary Security Facilities (SFs) and specialized workers relative to the population in various neighborhoods. The analysis shows a stark contrast in security coverage between neighbourhoods, with the situation projected to worsen overall by 2030.

Tale 6: Spatial relationship between security facilities, population and projections

Neighbourhood	No. of SFs	2024 Population	2030 Population	Ratio of security post to Population 2024	Ratio of security post to Population 2030	Ranked security post to Population	Ranked difference (d)	Ranked difference (d ²)
Molyko	27	9545	10922	354:1	406:1	10 th	0	0
Soppo	15	7719	8832	515:1	589:1	6 th	0	0
Buea Town	5	15711	17978	3142:1	3595:1	9 th	0	0
GRA	2	2270	2597	1135:1	1299:1	1 st	2	4
Sandpit	2	6731	7702	3366:1	3851:1	5 th	0	0
Bokoko	3	1162	1329	387:1	443:1	2 nd	2	4
Bokwai	4	1050	1201	263:1	300:1	3 rd	4	16
Bokwango	11	7062	8081	643:1	735:1	4 th	4	16
Muea	13	8701	13389	669:1	1029:1	7 th	-6	36
Bomaka	2	1086	7531	543:1	3766:1	8 th	-6	36
Mile 16	2	9348	10696	4674:1	5348:1	11 th	0	0
Bokova	1	327	374	327:1	374:1	12 th	0	0
Total	31	80,157	90,632	-	-			112

Source: Sub Divisional Office, Buea 2024, Population, 2030 Projections and Fieldwork, 2024

From Table 6, Bokwai (263:1), Molyko (354:1), and Bokoko Biaka (387:1) enjoyed the lowest ratios, suggesting a high spatial concentration of security posts relative to the population. Mile 16 was the most severely underserved neighbourhood with a ratio of 4,674:1. This means one security post was responsible for over four thousand residents—a coverage gap that poses a severe public security risk. Sandpit (3,366:1) and Buea Town (3,142:1) also face significant underservice despite their large populations. The overall population was projected to increase from 80,157 to 90,632 by 2030, putting inevitable strain on fixed security infrastructure. For neighbourhoods like Molyko and Buea Town, the ratio worsens, as the number of SFs remains constant while the population increases. While the case of Soppo's ratio deteriorated from 515:1 to 589:1. Bomaka's population is projected to soar from 1,086 to 7,531. Despite this massive growth, its ratio improves from 543:1 to 3,766:1 which is counter-intuitive for a fixed number of facilities (2 SFs). This suggests a re-evaluation or re-categorisation of the 'SFs' in Bomaka or a significant unstated factor driving the ratio down (27531= 3766:1) shows a catastrophic deterioration, not an improvement. Mile 16 remains the worst-served area, with its ratio worsening to 5,348:1.

Bokwai, Bokwango, GRA, and Bokoko Biaka have positive rank differences (d≥2), which indicates a relatively high ranking (good coverage/low ratio) despite their smaller populations. These small neighbourhoods are currently over-represented in security provision relative to their size. Contrarily, Muea and Bomaka have the highest negative difference (d=-6). This strongly suggests that these neighbourhoods, despite their significantly larger populations, are underserved relative to the optimal spatial distribution model. They are high-demand areas where the number of security facilities has failed to keep pace with the residential population.

3.2 Implications of Spatial Inequality on Population Well-being

3.2.1 Healthcare Outcomes and Quality of Life

The spatial inequality in healthcare provision observed between neighborhoods in Buea directly translates into reduced wellbeing and life-threatening delays for the population. Spatial inequality has leads to significant time and distance barriers, making it impossible for many residents, especially in peri-urban areas, to access care within globally accepted functional standards. The global best practice for emergency care is a 15-minute critical time threshold to reduce mortality, crucial for the golden hour of medical intervention. As a concept, it is use in trauma care, emphasizing that the first 60 minutes following a traumatic injury (or other critical event)

are crucial for maximizing survival and minimizing irreversible damage. In Buea, spatial constraints, road degradation, and traffic congestion has breach this limit, making ambulance or patient transport capacity ineffective for critically ill or injured individuals. For non-emergency routine care, the acceptable standard is a maximum of 30 minutes (sometimes exceeding 1 km in high-congestion and rural areas. A travel time above 40 minutes in the peri-urban settlements of Buea was due to inaccessibility, delays, high travel time, cost, and distances which have overwhelmed the population's ability to handle emerging and recurrent healthcare needs. This has resulted in low utilization rates for preventive and routine health services, leading to poorer long-term health outcomes. Overall, there was a statistical significant difference (p-Value=0.004) on the impact of healthcare accessibility on the local population across different neighbourhoods in Buea.

Spatial inequality is a major determinant in the vulnerability and fatality rates during public health emergencies, as evidenced by the recurring cholera outbreaks and low immunization rates. Outbreaks are consistently prevalent in slum settlements and peri-urban neighborhoods like Mile 16, which suffer from informality, limited interventions, basic amenities, WaSH facilities, and water insecurity. The cholera cases recorded in Buea in 2011 (totaling 1,329 cases) and the later outbreak in November 2023 (12 cases and two deaths in Mile 16 alone, with a case fatality rate of 13.2%) demonstrate that limited facilities, equipment, and slow response to patients contribute to high mortality. The spatial inaccessibility of Mile 16 likely amplified the fatality rate due to delays in care and personels. The combination of mounting environmental pollution, road degradation, traffic congestion, and limited government interventions have not only lengthened travel time to health facilities but have also created a persistently stressful and unhealthy living environment for the residents in Buea. This has negatively impacted the population's overall quality of life and wellbeing beyond the direct disease burden. Limited finance and capacity to adequately respond to outbreaks, noted by the inter-agency mission, was often more pronounced in spatially disadvantaged zones. This has ensured a very slow and insufficient response to crises.

3.2.2 Security and Social Stability Outcomes

Data on perceived security, trust in services, and vulnerability in spatially marginalized areas shows a far reaching implications for the residents as over 70% are unable to benefit from safety and security, which is a potential ingredient for urban livability. Field observation noted that Molyko neighbourhood has the highest rate of crimes due to a single police station, despite the high population and social services night clubs, bars, and snacks,

among which require maximum safety and security. Overall, the time taken to access security services have exceeded the norms more especially in Molyko a highly concentrated urban center and Mile 16 an informal settlement, which reported delays exceeding a minimum of 40 minutes. The standard Critical Response (SF) ranges from 5 to 10 minutes as a window of effective intervention for crimes such as robbery in progress and high-deterrence visibility patrols. Hence, with delays above 10 minutes in Buea, the ability to deter crime or apprehend suspects is far fetch.

Consequently, most of the underserved neighborhoods like Muea, Mile 16 are those experiencing the worst crimes as reported by statistics from the Legal Department in the Court of First Instance, Police Station of Muea, Molyko, Central and First district in Buea (Table 10). The main crime categories experienced by respondent were emergency (armed robbery, theft, kidnappings and aggravated assaults) with a proportion of 55.81%, followed by public order (violations of injunctions, noise and traffic infractions) with a proportion of (33.95%), property (burglary, larceny, vandalism and vehicle theft), (7.91%) and administrative (drug abuse and sale, prostitution) with a proportion of 1.4% of sample respondents. The upsurge in crimes were unemployment (59.76%), limited parental controls (10.69%), laziness (11.63%), limited intervention (2.79%) and peer pressure (5.12%) and drug consumption (Cannabis, Marijuana, Cayo and Tramadol) (11.63%). It was evident that these categories of crime were highly prevalent among youth migrants who are influenced by limited livelihood opportunities, growing informality, poverty, unemployment, illiteracy and social exclusion. Figure 5, derived using KDE, presents the spatial incidence and intensity rates of crimes in Buea, classifying areas into High, Moderate, and Low Crime Zones. Figure 6 presents the spatial incidences and intensity of property crimes with variations away from the center. As seen on Figure 5 critical zones are where high crime spatially concurred with poor accessibility.

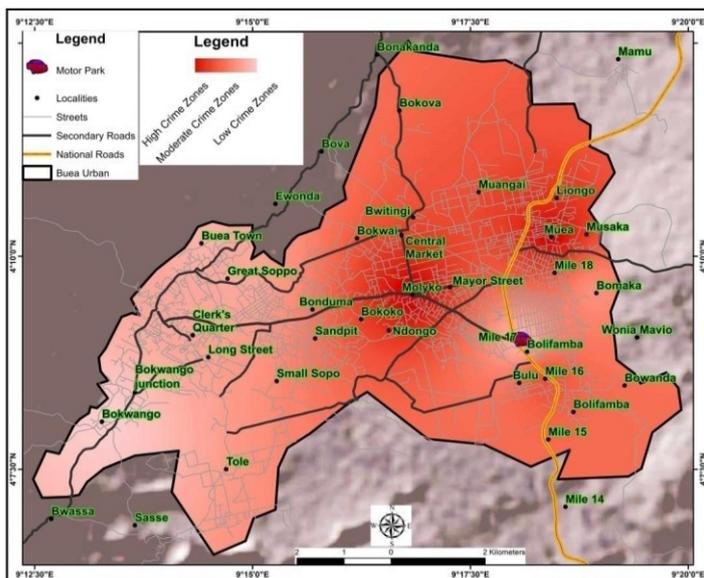


Figure 5: Incidence of Insecurity Challenges in Buea

KDE-derived High/Moderate/Low Crime Intensity

Source: Adapted from the Administrative Map of Buea Integrated with Fieldwork 2024

The highest intensity of insecurity is concentrated in the central core of the urban area. This core includes key areas like Molyko, Central Market, Bokwai, Mile 17, and extending towards Ndongo and Bokoko.

The location of Motor Parks alongside high-risk points such as Molyko, Mile 17 corridor has facilitated crime and create vulnerabilities for travelers, affecting economic activity and transport safety including an environment of fear and stress, eroding the psychological wellbeing of residents. This chronic stress has lead to reduced social cohesion and neighborhood watchfulness. Crime intensity decreases in a radiating pattern away from the central core. These zones cover much of the surrounding urban area, including Mile 15, and parts of Soppo. However, with the advent of the crisis there are experiencing high rate of crimes due to limited interventions and recurrent abuse, harassment and intimidations. Areas with the lowest crime incidence are typically on the periphery, such as Mile 14, Mile 15, Bokwango, and the northern/western outskirts like Bova and Ewonda. Unfortunately, poor accessibility have impeded emergency services (police, fire and ambulance), making these areas highly vulnerable and unsustainable. Significantly, simply having high crime isn't the only factor; difficulty in intervention or escape exacerbates the risk. Figure 6 specifically maps the intensity of property crimes using high-to-low color gradient to illustrate the density of these crimes.

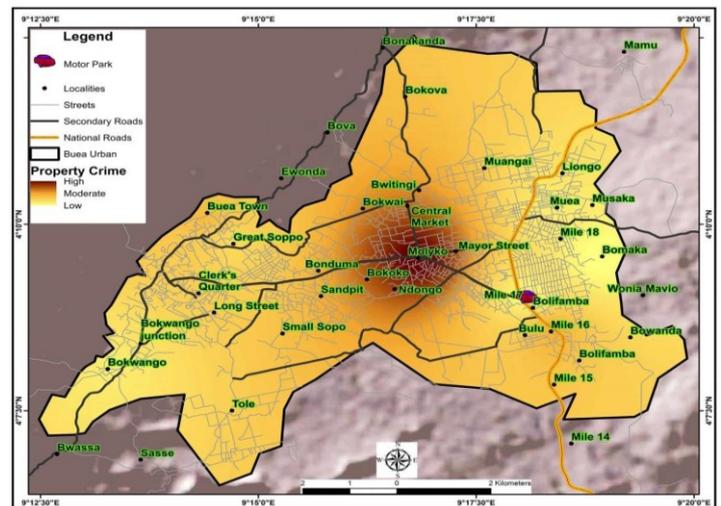


Figure 6: Incidence of Property Crimes

Source: Adapted from the Administrative Map of Buea, 2016

Figures 6 show a clear concentration of high property crime incidence in the central part of the city, specifically around Molyko and extending towards Mile 17. Many property crimes were specifically recorded in Mile 16, Muea, and Molyko. These areas are likely characterized by high population density, socioeconomic activities, and possibly poorer security accessibility. High concentration of property crimes in these areas highlighted the vulnerability of the most active commercial and student-populated area, demanding targeted policing and enhanced security infrastructure planning (CCTV and street lighting) to support a vibrant and safe public life. This is a key component of a sustainable city. Low incidence of property crimes was recorded in areas like Soppo, Buea Town, and Bokwango due to improved lighting, accessibility, and public safety.

3.3 The Role of Planning Policies in Perpetuating/Mitigating Inequality

3.3.1 Urban Planning Policy Deficits and Land Regulation Failure

This section analyses specific failures in spatial urban planning regulations that permit uncontrolled land use.

The urban planning regulatory frameworks for service delivery in Cameroon and Buea specifically aimed for universal and equitable access. The implementation institution for health care included MINSANTE as the central body responsible for setting and enforcing health standards, licensing facilities, and overseeing the public health system. The Cameroon Medical Council is responsible for professional registration and credential verification of medical practitioners. The institutions responsible for security and justice include the Ministry of Defense, the National Gendarmerie, the General Delegation for National Security (DGSN), the Ministry of Justice, and the Judiciary.

The key laws guiding healthcare planning and equality assessed in this study include the Constitution (Law N° 96/06 of January 18, 1996) in one of its Preambles and subsequent amendments, such as the 2008 revision, guarantee equality of all persons, preventive healthcare, accessibility, equitable distribution of resources, and affirm commitment to international human rights instruments. This same law ensures that all citizens are protected and can access justice. This constitutional principle applies to law enforcement and justice institutions and to all access-to-health policies. The Public Health Code / Medical Practice Act and Ministerial Regulations form the core legal framework for medical practices, set standards for quality, accessibility, and professional conduct including the Cameroon Code of Transparency and Good Governance in Public Health Finance Management (TGPHFM, 2018) calls for the promotion of transparency and accountability in the management of public resources the National Health Policy (2020) aims to improve access to health services, reduce maternal mortality, and lower HIV prevalence, indicating a policy commitment to addressing existing disparities.

The Universal Health Coverage (UHC) Initiative in Cameroon works towards achieving UHC by 2035, including legal and financial mechanisms to ensure all citizens have access to the care they need without financial hardship. This includes exploring financing through state budgets and health taxes. Law N° 2019/024 on Decentralized Local Authorities delegates significant health competencies to local councils, making them the direct guarantors of local public health services and access. The African Charter on Human and Peoples' Rights (ratified by Cameroon) in its Article 13 guarantees every individual the right of access to public property and services in strict equality of all persons before the law, while the General Statute of the State Public Function gives all citizens, without distinction on the grounds of sex, the right to have access to public functions.

Despite these enormous frameworks and their promotion mechanisms for service equality, content data analysis on their level of policy's effectiveness revealed significant disparities persist, often due to financial barriers, corruption, and unequal distribution of resources, and a top-down, up urban planning approach which makes citizen participation in decision making difficult. For instance, despite the adoption of the Town Planning Laws, the existing Buea Master Plan was either non-existent, outdated, or unvalidated. This has led to a legal vacuum where current developments on social justice in service accessibility were not properly guided or sanctioned.

The regulatory framework for urban planning is largely governed by decentralization laws and specific town planning legislation, aiming for harmonious development and equitable service delivery by local authorities. The Law N° 2004/003 of April 21, 2004, governing Town Planning stipulates that the State and the decentralised local authorities (CTDs) has the right to

manage and safeguard the national territory within their respective competencies (Article 2), harmonious and coherent development of human settlements by promoting the rational use of land and the improvement of living conditions (Article 3) and have mandates that land generally may only be built on if it is served by public or private roads and allows access for emergency and road services (Article 12), which is a key measure for ensuring a basic level of service access and Chapter II, section 49 which guarantees effective collaboration and implementation through consultation, training and research.

This, however, goes against the Decentralization Laws No. 2004/17, Law No. 2004/18, which transfer powers to regional and local authorities for service delivery, including town planning. It focuses on CSOs' participation through partnership and advisory role, consultation on key development plans and budget issues, and participation in urban planning meetings. The follow-up Law N° 2019/024 of December 24, 2019, bearing the General Code of Decentralized Local Authorities, significantly restructured the administrative landscape, devolving substantial powers from the State to Regions and Communes, which aimed at reinforcing and strengthening local governance of service delivery through citizen participation. Despite these, the law still follow a top-down approach in Buea. For instance, while the Buea Council has the mandate to grant building permits and manage local services delivery, including health and security, the ultimate authority to sanction illegal development and approve planning documents and finances remains with the central government, leading to administrative delays and inertia.

Despite the adoption of the CDP in 2012, there are still persistent challenges in service delivery and standards. These official council documents contain aspirational goals for the whole municipality but lack measurable, legally enforceable spatial standards, making it impossible to enforce equity in land-use decisions. For instance, the system is described as inequitable, with well-off regions and households having better access to health and security services like in GRA, which is a highly indigenous/administrative, high-class residential area than low-income and non-indigenous neighbourhoods of Mile 16.

Direct payment for services is a major setback for many families in unplanned settlements, while the Municipal Council lacks comprehensive risk-sharing mechanisms (health insurance) in the CDP (2012) for low-income denizens. There are shortage of medicine, adequate facilities, high degradation of infrastructure and medical personnel. There are stark geographic inequalities in the distribution of health personnel, with a high concentration of doctors in urban settlements where the Regional Hospitals and Government Health Centers are more concentrated compared with peri-urban areas, with even higher population sizes. Pervasive corruption is a critical issue, where citizens are forced to pay bribes for services that should be free, directly violating healthcare access policies in Cameroon. In many instances, out-of-pocket expenditure is high and residents rely solely on personal spending. These governance instruments, especially at the level of the council, seem to be on paper because the level of implementation for spatial justice seems far-fetched, especially considering the objectives of achieving target goals.

3.3.2 Enforcement, Investment, and Resource Gaps

Findings on the limited enforcement and chronic under-investment in social services and infrastructure are direct causes of the spatial gaps.

While legal frameworks promote equal access, content analysis of results noted high level of corruption, lack of infrastructure, human resources in under served areas, and the ongoing political crisis perpetuating spatial injustice in service delivery. This has severely impeded equitable access to security and justice for all citizens, especially vulnerable populations and those in remote areas. For instance security officers collect bribes rather than maintaining law and order in key junctions within the town. Also, limited, degraded or non-existent streetlights and the persistent crisis aggravated high crimes in these areas, resulting in massive arrests, detentions with significant human right violations. Moreover, mismanagement of funds and unethical practices in hospitals have hindered effective service delivery. The number of patient per doctor is limited with most existing doctors placed on calls to be able to attend to the patient. Health facilities faced deficiencies in incubators resulting in limited carrying capacity.

Thematic analysis from interviews with stakeholders yielded three core themes explaining the ineffective enactment of planning laws, confirming a significant governance-reality gap. Interviewees consistently reported a political environment that undermines enforcement. Planning regulations are frequently overridden by political directives. For instance, one official noted that: *"When you try to stop the admission of a patient due to space, equipment, or finances, the person just makes one phone call to a political superior... and your enforcement order is immediately withdrawn. The law is not applied equally, especially not to the wealthy or politically connected."* Medical Officer, Regional Hospital, Age 42, Male. This lack of autonomy and political backing prevents officials from enforcing health and security standards, allowing unhealthy ethical practices like bribery to impede service pathways and ensuring spatial justice remains profitable for a few.

Moreover, planning and service delivery agencies often fail to coordinate their actions, especially in the allocation of health and security infrastructure with the population that is directly involved. One respondent noted *"The political elites of Buea lobby for where to place health services without considering the population needs and threshold to access these services, resulting in service inaccessibility and degradation due to limited use."* In this case, service provisions are based on bias due to a weak institutional silo approach. Hence, spontaneous neighborhoods without political representation are systematically denied efficient service access. The professional role of the planner in the Council has been reduced to a revenue-generating, transactional one, divorced from its regulatory function rather than ensuring the security and well-being of the citizen as outlined in the decentralization laws of 2019. One respondent noted: *"Our job has become a transactional, mostly collecting building permit fees. We don't have the personnel, the vehicles, or the security to monitor a massive, sprawling town like Buea. Our budget is for the office, not for the field."* This institutional inertia has facilitated the conversion of designated public spaces into residential zones, directly worsening public health and security situations.

Based on the physical consequences of unmanaged spatial growth on emergency response, one respondent noted: *"Our patrols and emergency response are severely handicapped. In the unplanned areas, streets are often too narrow for our vehicles due to limited investment in maintenance and expansion. If we get a call about an incident in 'Mile 16, or Ndongo Neighbourhood backside,' we rely on a guide running ahead of the car and the resident risk charges for our services."*

The failure to enforce zoning and demand street layouts means our response time goes from 10 to 45 minutes, and in security work, that difference is critical." Police Officer; Age 55, Male.

Awareness can determine the extent of stakeholders' compliance with these regulatory frameworks. From the survey, 63% of respondents were not aware of this legislation, against 37% who were aware. The spatial inequality resulting from the ineffective enactment of these planning laws showed that there is a highly significant disparity in emergency vehicle access ($p < 0.041$), with over half of households in unplanned areas being inaccessible to standard police or ambulance vehicles, spending approximately four times longer accessing essential health services compared to those in planned areas ($p < 0.032$). This dramatic difference directly results from the failure of the planning regime to enforce standards for land reservation and road networks. Also, 3/4 of households in unplanned settlements face unacceptable police response times ($p < 0.017$), reflecting the security implications of spatial disorder where vehicles cannot navigate unmapped, congested paths resulting from unchecked construction. According to survey responses, 80% of respondents believe government policies and funding may likely be effective or highly effective in addressing spatial injustice, especially in low-income settlements. Specifically, 46% viewed these measures may highly be effective, while 34% find them effective. A smaller proportion, 14%, of the respondents considers government efforts slightly effective, while 6% perceive them as ineffective in addressing accessibility challenges.

4. Discussions

The skewed distribution of both healthcare and security services in Buea is a clear manifestation of spatial injustice [35,36]. This pattern aligned with critiques of the Neoliberal City in the Global South, where state resources are often channeled to serve politically influential and economically dominant areas, leading to the marginalization of low-income and peripheral settlements [43]. Neoliberal planning promotes elite interests over the needs of the poor, limiting their right to the city. The high dominance of Primary Healthcare (76.47%) and the scarcity of complex tertiary care mirrors a general trend in many African cities where basic services are more widely distributed, often through limited government and community/religious initiatives, while specialized services remain centrally located and less accessible to the urban poor [43]. The finding that hosting communities often provide the physical facilities for primary care suggests a reliance on community self-provisioning, which often compensates for inadequate government investment [44]. This uneven development has reinforced health disparities in Buea, as residents in underserved areas must travel farther or pay more to access specialized treatment. According to [45], PHC is rooted in the right to the highest attainable standard of health for all, emphasizing social justice, equity, and people-centered care across the lifespan. The functional standard of 15 minutes for health emergency care (HC), critical for reducing morbidity and mortality and based on the universally accepted concept of the 'Golden Hour' of medical intervention by [46, 47] was not met in Buea, as residents travel over 40 minutes to access HFs. The concentration of Police (78.47%) and Gendarmerie posts in wealthy areas and the resultant vulnerability of neighborhoods like Molyko and the new/outlying settlements illustrate the concept of stratified citizenship [48]. In this context, security becomes a privilege for the affluent rather than a right guaranteed by the state to all residents.

The reliance on community vigilante groups in neighborhoods like Bomaka further underscores the withdrawal or failure of the state to provide ubiquitous security, forcing marginalized communities to develop informal and often precarious security measures. This is a common phenomenon in peri-urban and informal settlements across African cities[49].

The results clearly linked service deficits to high crime rates, which aligned with Social Disorganization Theory in criminology, adapted for the urban context of developing countries which proposes that a breakdown of social institutions and networks in a neighborhood leads to higher crime rates[50]. Service deficits can disrupt social ties and weaken informal social control, leading to community disorganization and increased crimes. The dominant causes of crime identified are strongly correlated with the spatial inequalities observed. Informal settlement lack both formal surveillance and economic opportunities, creating an environment ripe for crime, which aligned with the work of [41] on slum challenges in SSA cities. These factors have contributed to high rates of theft (55.81%) and other social vices, highlighting that the context is not merely a policing issue, but a profound problem of marginality in developing cities [51].

The study revealed a profound governance-reality gap, where robust, equality-promoting legislation on service delivery exists on paper but is systematically undermined by institutional failures, political interference, and spatial disorder on the ground. This disconnection between de jure planning mandates and de facto urban development is a defining feature of cities facing institutional decay in Africa[52]. The legal framework is characterized by a central paradox. This centralization-decentralization conflict has created a structural bottleneck, leading to administrative delays and inertia. Local authorities are legally made the guarantors of local services, but lack the final authority to sanction illegal development or approve crucial planning documents. This legal vacuum is the fundamental cause of informality that directly impedes service delivery. The failure to enforce zoning and reserve land for public services is a classic example of state failure in land management prevalent in SSA Cities[53].

Sectoral laws mandate standards but fail to legally bind the local Council to reserve and zone the necessary land. This spatial blindness in sectoral planning means services are shoe-horned into inappropriate locations after settlements exist, driven by political expediency rather than population need or threshold to access. This exemplifies the challenges of urban governance in Africa, where Ministries operate independently, undermining integrated urban development [54]. This has consequences that result in quantifiable extreme spatial injustice, which is reflective of a form of urban apartheid [36]. The high concentration of doctors and specialized facilities in planned areas highlights the geographic inequality in health personnel distribution. This reinforces the concept of the Inverse Care Law [55], where people with the greatest health needs have the least access to medical care.

Furthermore, the prevalence of corruption and direct payment for services despite legal guarantees has transformed the public health of Buea from a right into a commodity. This financial barrier, combined with the spatial barrier of long travel times and the high out-of-pocket expenditure, is a primary mechanism for reproducing poverty and inequality in Africa[56].

The thematic analysis confirms that political and institutional decay is the key impediment to implementing the law, echoing the literature on patrimonial urbanism in Africa [57].

Despite the emphasis on citizen involvement, this study confirms the failure of the "top-down approach". Meaningful participation cannot occur if the denizens are uninformed, further cementing the institutional silo approach where decisions on service provision are made without considering the community's needs and thresholds. The high level of perceived effectiveness of government policies and funding in addressing accessibility issues highlights that the lack of capacity or political will, not the lack of framework or resources, is the fundamental issue of spatial injustice in service delivery.

5. Conclusion and Policy Implications

This study provides compelling empirical evidence regarding the persistent and detrimental effects of spatial inequality in service delivery within rapidly urbanizing contexts in SSA, using the city of Buea, Cameroon, as a critical case. Our initial premise, which highlighted the urgent need to reassess service patterns amidst significant demographic shifts, was validated by the findings. While theoretical commitments to inclusive and effective service provision abound in sustainable urban planning, the reality on the ground, driven by dynamic immigration and ineffective policy enforcement, revealed significant spatial disparities that directly undermine urban sustainability. The study revealed significant variations in the accessibility of both healthcare and security services across neighbourhoods. Despite seemingly favorable distance metrics, this quantitative proximity is fundamentally undermined by critical qualitative factors. Specifically, road degradation, rapid and informal urbanization, and insufficient investment have created significant barriers to genuine physical accessibility and operational efficiency. This disconnect between idealized planning norms and lived reality represents a core scientific contribution, demonstrating that distance alone is an insufficient measure of true service equity in SSA cities. The study empirically grounds the theoretical argument that regulatory failures and limited capacity have perpetuated inequalities, leading to high pressure and systemic inefficiency in meeting people's needs.

The documented inequalities carry profound implications for the overall well-being and resilience of Buea's population, confirming the critical link between spatial planning and social outcomes. The resulting service inefficiencies impact health equity and security, further marginalizing already underserved communities. Crucially, the analysis of planning policies exposed a critical gap: existing regulations are either inadequate for the current pace of urbanization or suffer from limited enforcement. This systemic failure to strategically direct investments and control urban expansion directly contributes to the observed spatial injustice. In response to these findings, we propose a strategic framework for reimagining social service delivery in SSA cities. This framework emphasizes a pro-poor, proactive, and evidence-based approach centered on:

Planning interventions should focus on decentralizing tertiary healthcare facilities and strategically placing security posts in high-density, high-vulnerability neighborhoods using a needs-based and population-density-weighted metric rather than political influence or existing wealth concentration, including moving beyond simple distance metrics to account for infrastructural quality and population density. To combat crime, drivers like unemployment, urban planning must integrate physical security with socioeconomic security. This involves directing resources specifically towards marginalized communities to both upgrade access infrastructure and decentralize service points.

These would help deter crime, alongside the creation of opportunities and youth programs to address the main cause of crime, thereby shifting from a repressive security model to a preventive one.

There is the need for stakeholders to focus on improving the operational and enforcement capabilities of local service delivery agents and urban planners through comprehensive public awareness campaigns that give citizens the rights to equitable services, establish a community-led monitoring groups and advocacy platforms that can provide grassroots intelligence needed to track service performance and promote direct accountability while translating complex national planning laws into accessible local languages. In addition to these, they should also focus on promoting policies that mandate the reallocation of resources, infrastructure development and spatial justice training to redress historical and emergent spatial disparities. These will ensure that equity principles are institutionalized and enforced on the ground. Finally, future planning efforts in Buea must adopt a multi-sectoral approach that moves beyond simple descriptive spatial mapping.

CRedit authorship contribution statement

Ngwani Awudu: Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Resources. Jude Ndifon Kimengsi: Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. Baba Adamu: Writing – original draft, reviewing and editing, Visualization, Formal analysis, Conceptualisation Software.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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