



Research article

Sustainability assessment of Nairobi Eastlands urban renewal plan (2016–2036), Kenya

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Abstract: Sustainable urban renewal is a strategy for addressing urban challenges, but its implementation is limited in Africa. In this paper, we assessed the sustainability of the Nairobi Eastlands urban renewal plan, the largest regeneration program in Kenya, using 12 indicators selected based on data availability and local context. The findings revealed significant variations in sustainability performance across estates. The sustainability of the plan was not influenced by density but by design layout, historical legacies, and location. Estates characterized by large open spaces and low population densities performed better in environmental sustainability, estates with evenly distributed public facilities had high social sustainability, and estates close to a central business district had high economic sustainability. Limited housing diversity and inadequate open spaces negatively affected economic and social sustainability. The paper highlights gaps in the renewal plan and possible strategies and demonstrates that sustainability assessment of plans can serve as an important decision-support tool for policymakers and urban planners in determining whether the proposed plan will promote sustainable development once implemented.

Keywords: Urban renewal; regeneration; sustainability assessment; indicators; Nairobi

1. Introduction

Sustainable urban renewal has been advocated since the 1990s to address urban problems [1], improve the quality of life, meet sustainable development [2], tackle housing deficits, and improve the city's image [3]. Urban renewal comprises different approaches, including renewal, regeneration,

redevelopment, restoration, and reuse of buildings, places, and urban lands [1,4]. The purpose of urban renewal is to revitalize urban environments, combat urban decay, upgrade infrastructure, resolve housing shortages, improve quality of life, enhance access to social services, and improve economic, environmental, and ecological conditions [5–7]. The implementation of sustainable urban renewal is insufficient [8], especially in integrating and balancing sustainability criteria [1,9]. Urban renewal projects have been criticized for promoting social segregation, being profit-driven, and leading to the loss of community identity [7]. Although urban renewal has been criticized, there is a need for better decision-making in its implementation [7] because, if well implemented, it can lead to sustainable development [7]. Assessing the sustainability performance of urban renewal [10] offers policymakers a forward-looking strategy in tackling sustainability issues from a comprehensive standpoint [4], with the Nairobi Eastlands urban renewal plan being no exception. From a policy perspective, early evaluation is imperative in identifying problems and remedying them [7] through plan review or if it is not tenable, it can be terminated before implementation.

Indicator-based approaches are considered useful for urban renewal decision-making, sustainability assessment, and research [1,4,7,11,12], but there is no consensus on which indicators to use in sustainability assessment since their application varies across contexts [11]. Indicator-based sustainability assessment has not been applied in Africa due to the limited consideration of context-specific issues, which is a major limitation of sustainability assessment tools [13–16]. Data constraints remain a significant barrier to sustainability assessment in African cities, with most studies relying on primary data collection that is often infeasible in resource-constrained contexts [17]. Due to this challenge, we use localized indicators to assess the sustainability of Eastlands' urban renewal plan before implementation, demonstrating that urban (renewal) plans can be assessed even in data-scarce contexts typical of African cities.

This paper is anchored on southern urbanism theory [17], which (a) calls for flexibility in how cities are designed, planned, and compared in globalization era [17], (b) challenges universal application of one-size-fits-all Western-centric planning paradigms that disregard (post)colonial, historical, cultural, and socioeconomic realities and performance in African cities [17], and (c) accounts for the informality and diversity that characterize Global South cities [18]. The theory also aligns with the application of context-specific indicators in assessing the sustainability of African cities [17], especially in Kenyan urban centres characterized by informal economies, differentiated spaces, and (post)colonial spatial legacies [19,20].

Urban renewal approaches in Kenya over the past five decades have largely focused on upgrading informal settlements, with shifts and continuities. The urban renewal approaches in the 1960s and 1970s entailed slum removal and low-rise redevelopment of low-income public housing [21]. In the 1970s, it was slum removal coupled with site and service schemes and low-rise redevelopment of low and middle-income housing under self-help efforts [22–24]. In the 1980s, it entailed demolition of informal settlements and redevelopment of low-rise and high-rise housing through site and service schemes, tenure regularization, and infrastructure improvements [23,25]. Urban renewal in the 1990s and 2000s entailed slum removal, high-rise redevelopment, participatory tenure regularization, upgrading of basic infrastructure and services, and encouragement of beneficiaries to improve their housing structures and environment through self-help efforts [25–31]. In the 2010s, it was through informal settlement tenure regularization, basic infrastructure provision, and community involvement [32,33]. Currently (2020s), urban renewal entails tenure regularization [34], redevelopment and densification of previous public housing [35], and regeneration of dilapidated old neighbourhoods [36].

Kenya's urban renewal approaches reflect broader urban planning and modernity trajectories. First, the redevelopment of demolished informal (slum) settlements and substandard housing through public housing programs and site and service schemes can be viewed as a state-led, top-down approach [37] to city-making from above [38] in pursuit of urban modernity ideals to address colonial racial segregation, planning, and development legacies. Planning of residential neighbourhoods during the colonial period was based on racial segregation, where residential areas were partitioned into European, Asian, and African zones, with the latter characterized by poor housing, infrastructure, and service provision, and upheld through the Public Health Act, planning laws, exclusionary zoning regulations, and sanitary buffers [20,39–42]. After independence, segregation shifted to spatial (formal and informal settlements), income status, tenure, and density [42] and was upheld through exclusive land-use zoning in the 1973 Nairobi Metropolitan Growth Strategy and 1979 Rezoning Policy [40]. Second, tenure regularization can be viewed as regularizing informal city-making from below [43] through bottom-up [37], participatory, adoptive planning, titling, and upgrading of basic infrastructure and services to enable owners (households) to upgrade their houses due to security of tenure and an improved living environment. Third, regeneration through demolition of old and dilapidated public housing estates, rezoning from low to mixed-use high-density residential, office, and commercial areas, and redevelopment through a citizen-taxed public-financed affordable housing program can be viewed as a shift by the state from spatial segregation by land use, density, and class, toward sustainable urbanism characterized by high density, land use mix, housing diversity, and walkability. However, no researcher has assessed whether this shift to sustainable urbanism contributes to environmental, economic, and social sustainability.

Urban renewal studies in Kenya have mainly entailed post-implementation evaluation of urban renewal projects [44–47] and existing neighbourhoods [16] with limited emphasis on assessing sustainability performance at the planning stage. There is no ex-ante evaluation mechanism to determine whether the proposed urban renewal project will achieve sustainable development [1]. Therefore, we assess the sustainability of the Nairobi Eastlands Urban Renewal Plan (2016–2036) using a localized indicators-based assessment framework, as proposed in [7]. Our ex-ante (pre-implementation) assessment of the plan demonstrates how southern urbanism theory can be operationalized in sustainability assessments of urban renewal plans, as well as in situating the assessment within Kenya's strategic environmental assessment (SEA), which stipulates the evaluation of environmental, social, and economic consequences of proposed policies, plans, or programs prior to their implementation [48]. The Eastlands renewal plan is a formal policy document guiding urban redevelopment, yet SEA practices often neglect the broader sustainability implications of urban plans, which we address by embedding sustainability assessment as an analytical framework in SEA.

Nairobi Eastlands was established during the colonial period to provide affordable housing for the low and middle-income urban workers [49–51]. However, Nairobi Eastlands has become slum-like due to dilapidated infrastructure and inadequate services over the past three decades [51], which precipitated the renewal plan. Assessing the Eastlands urban renewal plan before its implementation provides an opportunity to address sustainability gaps through plan review, thereby improving sustainability outcomes during implementation, since the plan has been prioritized for implementation through the affordable housing program. Without such assessments, urban renewal initiatives may fail to achieve sustainable development goals, particularly in Africa [52], or lead to costly and ineffective solutions [1].

2. Data and method

The Nairobi Eastlands urban renewal plan is selected as a case study because it is the largest regeneration plan in Kenya that has been prioritized for implementation by the national and county governments. Stratified simple random sampling was utilized to obtain a representative sample of building heights, estates, and a diverse view of sustainability performance. Of the seventeen estates in the plan, nine were sampled (Table 2; Figure 1); five estates with sixteen-floors, one with five floors, and three with eight floors. This stratification was employed because building height serves as fundamental information for characterizing urban landscapes and morphology [53], which significantly influence sustainability performance. The Eastlands renewal plan area is a high-density zone, but for the purpose of this assessment, buildings with five, eight, and sixteen floors are classified as low-rise, medium-rise, and high-rise, respectively. The classification is in line with the Nairobi zoning regulation, where density classification is no longer uniform, absolute, and pointer to income class as in the past, i.e., estates like Kilimani and Kileleshwa were low-density with bungalows and maisonettes, but the current zoning regulation allows up to 4-floor apartments [35,54].

Sustainability indicators were derived from literature review based on environmental, social, and economic criteria (Table 1), followed by their localization by selecting those for which data were readily available, given the challenges with data accessibility and availability that hinder the effective use of global indicators in African cities [17]. Use of locally and limited number of well-chosen indicators is imperative to avoid complications in interpreting and integrating results from available data [54] in the context of limited data availability, geographical condition, and ease of implementation and interpretability [7,12]. The selected indicators meet the southern urbanism theory criteria that they should be valid, appropriate, reliable, accurate, cost-effective, and have a short feedback time [55]. The selected indicators were those that could be measured using secondary data, particularly data available in the plan. Indicators that could not be measured from the plan were excluded, including energy, waste, carbon footprint, emissions, building condition, and community wellbeing, because they require more tangible outcomes that can be observed only after the plan implementation [7]. However, to provide a more comprehensive perspective, the excluded indicators are discussed qualitatively to evaluate the renewal plan's underlying provisions.

Data for the paper were acquired from the Nairobi Eastlands urban renewal plan, with the spatial (map) plan digitized in ArcMap. Accessibility of facilities was determined by distance and location using ArcGIS 10.8.2, with the Near tool used to calculate the Euclidean distance of residential plots from facilities (Table S1), as this is a good measure of spatial accessibility [56,57] and estimated relative to walking, bicycling, and driving distances [58,59].

Spearman's rank correlation was used to examine relationships among indicators (Table S2); negative correlations indicated inverse relationships, while positive correlations indicated direct relationships. Spearman correlation was computed using the Statistical Package for Social Sciences (SPSS), Version 27. Spearman correlation was selected because the data were non-parametric, and the method can be applied even when the sample size is relatively small [60].

Five steps were followed in assessing the sustainability of estates in the Eastlands urban renewal plan:

- i. Computation of raw sustainability indicators (Table S1) based on the formulas in Table 1.
- ii. Normalization of raw data from step 1 to make the results more comparable. Normalization was done using a categorical scale to have the same data range, because the categorical scale is not sensitive to outliers [55]; based on a 5-point Likert scale adopted from [61,62], where 1 = low

sustainability, 2 = medium-low sustainability, 3 = medium sustainability, 4 = Medium-high sustainability, and 5 = high sustainability, which agrees with most sustainability assessments that have used a Likert scale of 1–5 [63–65]. Table S3 shows categorical scale for normalization of indicators and how raw data were coded and normalized. Raw scores of less than 30% were normalized to scale 1; 30–50% scale 2; 50–70% scale 3; 70–90% scale 4; and over 90% scale 5. All indicators having high values had high sustainability, except for accessibility of facilities and population density normalization, which was done inversely, because a shorter access time and population density of 150/ha is considered sustainable [66]. The equation used to generate the five normalized scales for each indicator is:

$$\begin{aligned} \text{Scale 1} &= (B - A) \times \frac{30}{100} + A; \text{Scale 2} = (B - A) \times \frac{50}{100} + A; \text{Scale 3} = (B - A) \times \frac{70}{100} + A; \\ \text{Scale 4} &= (B - A) \times \frac{90}{100} + A; \text{Scale 5} = (B - A) \times \frac{90}{100} + A, \end{aligned}$$

where B = Maximum indicator score, and A = minimum indicator score.

iii. Equal weighting was used due to a lack of statistical or empirical evidence [67].

iv. Aggregation of indicators was conducted to obtain a composite sustainability index of estates using additive aggregation, arithmetic mean, since all indicators after normalization have the same measurement unit [67].

v. Determination of the overall sustainability index of each estate per criteria by aggregating the normalized indicators using the arithmetic mean Eq 1.

$$\text{Additive arithmetic mean} = \frac{n^i}{N}, \quad (1)$$

where N is the number of indicators, i is the indicator, and n is the sum of the normalized indicator data.

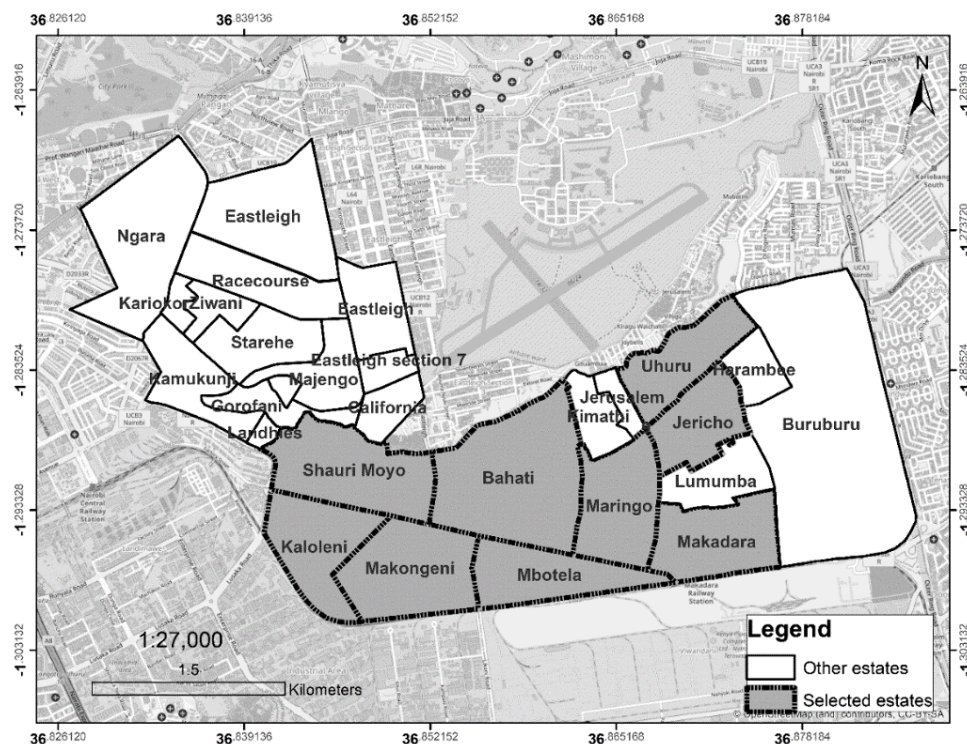


Figure 1. Location of sampled estates in the Nairobi Eastlands urban renewal plan.

Table 1. Sustainability indicators and computation formulas.

Criteria	Indicator	Formula	Units	Reference
Environmental	Open spaces	$\frac{\text{Total open space}}{\text{Population}}$	M ²	[68]
	Land use mix	$LUM = -\sum_{i=1}^N P_i \times \log_2 P_i$ where N is the number of different types of land use, P _i is the relative abundance of each land use, Log ₂ P _i is the logarithm (base 2) of the relative abundance of each land use type	Index	[69]
	Residential density	$\frac{\text{Dwelling units}}{\text{Residential area}}$	Dwellings/Ha	[55]
Social	Access to open spaces	Average distance	Distance (m)	[70]
	Access to a cultural facility	Average distance	Distance (m)	[70]
	Access to educational facility	Average distance	Distance (m)	[70]
	Access to public transport	Average distance	Distance (m)	[70]
	Access to a health facility	Average distance	Distance (m)	[70]
Economic	Housing diversity	$1 - \sum (\frac{n^2}{N})$ where n is the number of houses in one category and N is number of houses in all categories	Index	[55]
	Number of jobs per 1000 m ²	$\frac{\text{Employment area}(m^2) \times 0.8 \text{ uptake rate} \times 0.034 \text{ worker per}(m^2)}{\text{Site Area}(m^2)} \times 1000 m^2$	Index	[64]
	Employment density	$\frac{\text{Number of jobs}}{\text{Area}(m^2) \text{ allocated to commercial activities}}$	Index	[71]
	Population density	$\frac{\text{Number of people}}{\text{size of the area}}$		[7]

3. Results and discussions

3.1. Characteristics of Nairobi Eastland's urban renewal area

Nairobi Eastlands (Table 2; Figure 1) was patterned out of the racial segregation policy during the colonial era in the early 20th century and built between the 1920s and 1960s as low-income, affordable housing for African labourers working in Nairobi [72], with additional estates established after independence in the 1960s and 1970s. However, colonial housing was of poor quality and lacked adequate infrastructure [73], while postcolonial Eastlands

continued to be underdeveloped and characterized by illegal constructions, potholes, neglect, accumulation of refuse, degradation, and mismanagement [49,51,74,75], which set the stage for urban renewal.

The Nairobi Eastlands urban renewal plan was finalized in 2019 and approved by the Nairobi City County Government. The objectives of the plan are to a) provide an urban development framework for more than 20 years, b) deliver strategies to address urban blight in Eastlands, c) develop a functional urban system, d) recommend a responsive and sustainable development model, e) enhance access to affordable housing, and f) revitalize the economy. Implementation of the renewal plan is long-term and in phases, depending on funding and political will. The national government has started to implement the plan through the affordable housing levy, with Shauri Moyo, Starehe, and Makongeni estates launched, and construction ongoing under the affordable housing flagship project.

Table 2 summarizes the characteristics of Nairobi Eastlands, indicating the type of housing, the year they were built, and the basis for renewal. The urban renewal plan mixes units within a housing block to (a) create more stable, cohesive, and sustainable communities, (b) subsidize the cost of social housing by breaking up the concentration of disadvantaged tenants, (c) draw investment into the neighbourhood, with middle-income residents attracting shops, services, and investments, and (d) promote sharing of costs related to infrastructure and utility maintenance.

The one-bedroom units are placed around the busier parts of the floor, such as the stairs, while two and three-bedroom units are placed in the quieter parts of the floor. Housing affordability in the plan is achieved by first reducing the unit size to reduce the overall cost of construction, i.e., 30 m², 40 m², and 60 m² for one, two, and three bedrooms, respectively, compared to standard sizes of 45 m², 60 m², and 80 m², respectively. Second, the utilization of government land at no cost reduces the total cost of housing. Third, the government covers the cost of providing basic infrastructure, including roads, electricity, water, and sewerage. Fourth, proposed rental prices for sitting tenants are affordable. Fifth, the tenant purchase will offer flexible 25-year payment terms.

The government owns most of the land in Eastlands; hence, the tenants who will purchase the units will be given sectional titles, as per the Sectional Properties Act [76], which enables purchasers to obtain a registrable title. Tenants have no proprietary rights, regardless of how long they have resided in government housing. However, the plan proposes that an enumeration exercise be carried out in each estate before project implementation to formalize tenants' legal position during the transition period and to freeze the rental market. This is because the radical free-market does not enhance affordability [77].

3.2. *Environmental sustainability*

Open space assessment scores (Table 3) show that medium-rise estates (8 floors) have low sustainability (except Kapolei with high sustainability), high-rise estates (16 floors) have low sustainability (except Makadara with medium sustainability), and low-rise estates (5 floors) have medium sustainability. Estates with medium sustainability and above (Kaloleni, Uhuru, and Shauri Moyo) had cluster design layouts in the original plan that reserved large areas for open spaces, unlike estates with compact design layouts. Estates with large open spaces and low population density are more sustainable than those with limited open space and high population density. The plan aims to upgrade, refurbish, and expand underused facilities such as City Stadium and Majimbo Playground in Kaloleni and Kamukunji Grounds in Shauri Moyo, as well as establish a 90 m by 45 m sports complex

and two public parks in Makongeni estate and a recreational park within the secondary CBD to meet emerging needs. Open spaces reduce pollution [4], balance microclimates and runoff [78], and provide spaces for playing [63], which makes the environment liveable and healthy, thereby improving the quality of life.

Open space sizes vary across the estates, ranging from 26.3 m² to 4.2 m² per person (Table S1) compared to the World Health Organization's recommendation of 9–25 m² per person, with Makongeni, Bahati, Mbotela, Jericho, Uhuru, and Makadara not meeting the minimum standard. This shows that under the renewal plan, high-rise estates will lack adequate open spaces, and no estate will achieve both high density and high open space; hence, balancing density and open spaces will remain a challenge. This aligns with [65], who noted that high density leads to fewer open spaces due to competing trade-offs between population density and open space. High urban density is often promoted for sustainable development, offering benefits such as reduced emissions, efficient land use, and fostering innovation, but challenges such as overcrowding, noise, and limited access to green spaces often lead to increased stress and health problems [79]. Adoption of nature-based solutions (green roofs, facades, and vegetation) along streets and public right of way [80] can increase open spaces in high-rise estates.

Land use mix assessment scores (Table 3) vary across densities: High-rise estates exhibit high (Maringo) and low (Mbotela) sustainability, medium-rise estates range from medium-low to high sustainability, and low-rise estates exhibit medium-high sustainability. This implies that building height and density do not determine land-use mix, but rather estate planning and functional allocation of space. Land use mix values range from 0.5 to 0.7 (Table S1), indicating a moderate land use mix and functional diversity across estates, though residential use remains the dominant land use in all cases. This implies that, while the renewal plan has successfully integrated various land uses (residential, commercial, open, and green spaces), a balanced mix has not been achieved, as no estate has attained an index value of 1. A value of 1 reflects a balanced and sustainable land-use configuration that reduces pollution and limits urban sprawl [81–83]. Eastlands was mainly residential, covering 44.5% of the total area, but the renewal plan has reduced residential to 39.3% and increased commercial and industrial from 8.6% to 8.8%, and other land uses from 46.9% to 52%. The correlation between land use mix and access to facilities (Table S2) is positive for all facility types except cultural facilities, which show a negative correlation ($r = -0.08$) due to the low number of facilities. Mixed land use enables the use of non-motorized modes and shorter travel distances [82], which is consistent with our finding that a high land-use mix is associated with greater facility accessibility.

To promote a more balanced land use mix and prevent the emergence of mono-functional urban pockets, the strategies proposed in [66] were adapted in the renewal plan, including vertical zoning and permitting commercial activities on the first two lower floors and residential on the upper floors. The combination of complementary urban land uses encourages high population density [82]. The correlation between land use mix and population density (Table S2) is positive $r = 0.3$, indicating that a mixed land use supports high density through improved proximity, accessibility, and efficient use of urban land.

Table 2. Characteristics of estates and basis for renewal in Nairobi Eastlands urban renewal plan.

Estate	Existing residential characteristics					Renewal rationale	Urban renewal residential characteristics			
	Year built	Typology	Units	Density (Dwelling/Ha)	Nature of rooms		Units	Density (Dwelling/Ha)	Storey	Housing type
Bondeni	1942	Row housing	320	86	Single	Dilapidated housing	774	209	8	1–3 bedroom
Kaloleni	1928	Bungalow	1100	20	1–2 bedroom	Infrastructure decay, overcrowding	8132	149	8	1–3 bedroom
Gorofani	1952	Walk ups	700	56	1–2 bedroom	Housing deficit	1195	96	8	1–3 bedroom
Shauri Moyo	1939	Row housing	1000	14	Single	Aging building, poor infrastructure	4088	57	5	1–3 bedroom
Ziwani	1940	Row housing	1200	82	Double and kitchen	Aging housing	4782	328	8	1–3 bedroom
Starehe	1942	Row housing	1200	33	Double and kitchen	Overcrowding	5486	151	8	1–3 bedroom
Mbotela	1955	Row housing	1400	29	Single rooms	Dilapidated infrastructure, poor housing	15469	318	16	1–3 bedroom
Bahati	1950	Row housing	1200	11	Single room	Overcrowding, traffic congestion	32244	299	8	1–3 bedroom
Maringo	1955	1–2 storey	1200	22	Double and kitchen	Aging infrastructure, dilapidated housing	17020	309	16	1–3 bedroom
Jerusalem	1958	1–2 storey	1200	145	1–2 bedroom	Urban decay	7454	898	16	1–3 bedroom
Uhuru	1967	1–2 storey	1100	25	2–3 bedrooms	Aging infrastructure, inadequate housing	1999	45	16	1–3 bedroom
Makadara	1969	Row housing	1000	714	2 bedrooms	Road congestion, dilapidated building	10276	7340	16	1–3 bedroom
Pumwani	1922	Single story	324	31	Single	Dilapidated housing and infrastructure, overcrowding	70	7	5	1–3 bedroom
Makongeni	1945	Single row	100	2	Single rooms	Aging housing, illegal extensions, and inadequate services	27781	422	8	1–3 bedroom and hostels
Jericho	1962	2 storey maisonette row housing	1500	38	Single, 2–3 bedrooms	Aging housing, population pressure	26444	669	16	1–3 bedroom
Lumumba	1962	Single storey	1388	44	Single rooms	Dilapidated infrastructure	21520	685	16	1–3 bedroom
Kariokor	1929	Single-storey cubicles	16	3	1–2 bedroom	Aging housing	5064	1013	16	1–3 bedroom

Key: Shaded are sampled case study estates; 5 floors (low-rise); 8 floors (medium-rise); 16 floors (high-rise).

Residential density assessment scores vary across densities, with medium-rise and low-rise estates showing low sustainability, while high-rise estates exhibit varying sustainability, high, medium, and low. Correlation between residential density and open spaces (Table S2) is negative ($r = -0.4$), which indicates that high residential density leads to reduced open space. Although the renewal plan aims to increase housing stock, it is necessary to balance density and open spaces in the planning of high-rise estates such as Mbotela, Jericho, and Uhuru. Residential density influences land-use efficiency, transportation mode, housing affordability, walkability, and cost-effectiveness [84]. Balancing density and access to open spaces in cities is important for liveability [85]. Overall, environmental sustainability indicators such as open space, land-use mix, and residential density indicate that estates with open space and mixed land use (Shauri Moyo and Maringo) achieve better environmental performance. In contrast, densely built-up areas with minimal green space (Makadara and Mbotela) are more environmentally constrained. The environmental benefits of open/green spaces, high density, and land-use mix are to improve environmental quality [4,86], with Shauri Moyo and Maringo estates in the plan offering these benefits.

The Nairobi Eastlands urban renewal plan outlines other environmental sustainability strategies, including waste management and carbon emission reduction. Waste will be managed through the provision of color-coded waste bins for source-separated collection at the housing blocks. Green bins will be used for disposing of organic waste, brown for paper, and blue for inorganic waste. A total of 154 bins with a carrying capacity of 20 tons will be provided in Eastlands, and three waste collection and transfer points, each 0.4Ha in Shauri Moyo, Starehe, and Jericho. Eastlands will also have a material recovery facility in Shauri Moyo for e-waste, metal, glass, and plastics. A biogas plant and slurry factory will also be established to process animal feed and fertilizer.

Carbon emissions will be reduced in the plan by a) promoting the use of sustainable energy sources, b) adopting green building technologies, c) improving accessibility of facilities and putting up workspaces in the estates, d) restricting heavy industries in Eastlands, and e) providing green spaces. A total of 240 Solar panels will be installed on the roofs of the residential buildings to power corridor lighting and security lights. Solar water-heating panels with a capacity of 5,000 litres will also be installed on the rooftops of every building to reduce the overall energy costs and maintenance. Small-scale wind turbines will be installed on selected rooftop buildings and mounted on the street to supplement lighting. The plan will also encourage the use of rapid bus and light rail services, carpooling, and non-motorized transport to reduce emissions. Green building technologies will be used to construct mixed-use buildings in the Makadara node, and the parks will be constructed with recyclable materials. The buildings in the plan will utilize natural lighting to reduce electricity use, which is achieved through large windows that provide ample daylight into the rooms, complemented by newer energy-saving technologies. These strategies are not measurable but will enhance the overall sustainability of Eastlands.

3.3. *Social sustainability*

Accessibility assessment scores (Table 3) indicate that medium and low-rise estates have high sustainability due to their short distances to public transport, ranging from 34 to 55 metres (Table S1), which can improve residents' access to essential services, employment opportunities, and overall quality of life. High-rise estates show mixed sustainability (except Maringo, which has low sustainability due to limited access to public transport), which can increase reliance on private transport

and thus the need to establish additional bus terminuses. The high density in Maringo has not translated into accessible public transport within 5 minutes. The proposed public transport system in Eastlands is expected to play a significant role in residents' daily lives by improving access to services, supporting livelihoods, and enhancing overall well-being. The plan places considerable emphasis on access to public transport through mixed-use development and social interaction [87] to reduce dependence on private vehicles, lower transport costs, and support healthier, safer, and more cohesive communities [88]. An efficient public transport system provides better accessibility for all, with economic and environmental benefits [66].

Recreational accessibility assessment scores indicate that medium-rise estates have high sustainability, with recreational facilities well distributed and easily accessible, which contributes to improved overall well-being and quality of life. This is supported by [89,90], who emphasize that accessible recreation facilities provide spaces for exercise and relaxation, reduce the risk of chronic diseases and social barriers, and improve physical and mental well-being. Moreover, a low-rise estate exhibits medium-low sustainability because open spaces are not centrally distributed, whereas high-rise estates vary in sustainability from medium to high. Shauri Moyo (low-rise estate) features Kamukunji grounds as its primary open space that will be redesigned, upgraded, and expanded from 3.4 hectares to 4.5 hectares to accommodate skating, historical trails, and seating. However, it does not address the central issue of distribution; the upgraded grounds remain in a single location, potentially leaving other parts of the estate underserved. The Mbotela recreation space is at the periphery and not expanded in the plan, which undermines residents' accessibility. To address the lack of recreational spaces in Makongeni, the plan proposes a 90-by-45-metre sports complex and two public parks, coupled with the incorporation of green spaces in each residential court, which significantly enhances proximity and access to recreation in the neighbourhood. Low accessibility to recreation facilities leads to poor health outcomes, increased social inequality, reduced quality of life, and weaker community ties [91]. Therefore, accessible recreation facilities are one indicator of successful urban renewal. The plan should have redistributed recreation spaces to increase accessibility in Mbotela and Shauri Moyo estates.

Health accessibility assessment scores indicate that medium- and low-rise estates have high sustainability, with good access to health facilities that are spatially well distributed within the estates. Eastlands had 4 private hospitals, 11 health centres, 7 dispensaries, 2 nursing homes, and 2 clinics, but they were inadequate for the population. The plan proposes expanding and upgrading health facilities, i.e., clinics in Mbotela, Makongeni, and Uhuru, and the dispensary in Kaloleni and Makongeni to health centres. The health centres in Jericho, Bahati, Makadara, and Jerusalem will be upgraded and expanded. High accessibility leads to better access to healthcare services, overall health outcomes, and a high quality of life for residents. This significantly improves community health and resilience [92]. High-rise estates have mixed sustainability: Medium, medium-high, and high. Maringo estate is the exception, with low sustainability due to the health facility being at the periphery, because the health facility will be upgraded to a Level 4 Hospital, which will increase service capacity and catchment, but will not resolve underlying accessibility challenges in the neighbourhood. High accessibility is critical, as it leads to better service utilization, improved health outcomes, and a higher quality of life, which enhances community health and resiliency. Low accessibility results in an inequitable distribution of health facilities, worsening health disparities, and diminishing overall life expectancy [93]. Urban renewal projects may fail to be sustainable if health facilities are unavailable or inaccessible, regardless of their size or capacity, thereby hampering the long-term success of regeneration projects [92].

This finding underscores the need for upgrading, which is also accompanied by the redistribution of facilities to underserved areas to ensure equity.

Cultural accessibility assessment scores show that medium-rise estates have medium-high to high sustainability, while high-rise areas have low sustainability, except for Jericho and Mbotela, which retain a social hall from the original plan that the renewal plan has upgraded and expanded. This shows that historical legacies in the provision of cultural facilities play a role in the current plan: Estates that had them in the plan expanded them, while those without them did not create new provision. Access to cultural facilities enhances the quality of life and well-being [94]. Accessible cultural facilities are essential to urban renewal plans, as they enhance social inclusion, strengthen urban identity, and contribute to the long-term sustainability and vibrancy of cities [94]. Shauri Moyo, Maringo, and Makadara lack cultural facilities, which will make it harder for community members to get along and limit their chances to meet new people, interact, and share their culture. Cultural spaces promote social interaction, community identity, and discourse [94]. Their absence can result in social fragmentation, a diminished sense of belonging [95], aggravate social inequalities, and obstruct inclusive urban development [94,95]. Without accessible cultural spaces, urban renewal plans may fail to harness the full transformative potential of urban communities [96].

The educational accessibility assessment shows that medium-rise estates have high sustainability due to the spatial distribution of schools within them, whereas Makongeni is less sustainable because the two schools are at the periphery. Low- and high-rise residential areas are highly sustainable because schools are well distributed across the estates, except in Jericho and Makadara, where schools are at the edges of the estates and will remain difficult for students to reach. Generally, in the plan, schools will be expanded and upgraded to accommodate growing student populations. Proximity to schools makes it easy for children to access them, which is an important step in closing the gap between the rich and poor and making cities more welcoming to everyone [97]. Evenly distributed facilities improve overall accessibility [57]; hence, the need to redistribute schools in Makongeni, Jericho, and Makadara to improve accessibility.

Overall, social sustainability indicates that estates like Bahati, Kaloleni, and Uhuru will benefit from diverse, accessible education, recreation, health, and cultural facilities, thereby promoting inclusive and resilient communities. In contrast, estates like Makadara and Maringo will suffer from a weak social infrastructure, thus limiting residents' quality of life.

Beyond the accessibility indicators, the plan also promotes community well-being through a) improving and renewing infrastructure system in Eastlands, b) developing an extended network of public open spaces and public amenities within each neighbourhood, c) increasing housing units, d) improving safety and security in the public spaces by putting up street lights, mixing of residential and commercial land uses, e) preserving heritage resources and building new cultural and educational facilities, and f) landscaping and community involvement in the management of the estates.

Table 3. Neighbourhood sustainability assessment based on normalized scores in Eastlands urban renewal plan.

Criteria	Estates Indicators/Height	Kaloleni 8	Makongeni 8	Bahati 8	Shauri Moyo 5	Mbotela 16	Maringo 16	Jericho 16	Uhuru 16	Makadara 16
Environmental	Open space	5	1	1	4	1	1	1	3	1
	Land use mix	2	3	5	4	1	5	4	2	2
	Residential density	1	2	1	1	1	3	5	1	1
	Environmental Sustainability	2.7	2	2.3	3	1	3	3.3	2	1.3
Social	Education	4	1	5	5	4	5	1	5	1
	Public transport	4	4	5	5	5	1	5	5	3
	Recreation	5	5	5	2	1	5	5	5	3
	Health	5	5	5	5	3	1	3	5	3
	Cultural	5	4	4	1	4	1	5	1	1
	Social Sustainability	4.6	3.8	4.8	3.6	3.4	2.6	3.8	4.2	2.2
Economic	Net employment density	3	1	1	5	1	5	4	1	1
	Number of jobs	1	2	2	5	1	4	1	1	4
	Housing diversity	1	5	1	1	1	1	1	1	1
	New population density	5	3	5	5	4	4	1	3	5
	Economic Sustainability	2.5	2.8	2.3	4	1.8	3.5	1.8	1.5	2.8
Overall sustainability		3.3	2.9	3.1	3.5	2.05	3.0	2.9	2.5	2
		2	5	3	1	8	4	5	7	9

Sustainability assessment key: 0–<1 (Low), 1.1–2.0 (Medium-low), 2.1–3.0 (Medium), 3.1–4.0 (Medium-high), 4.1–5 (High).

3.4. Economic sustainability

The housing diversity assessment (Table 3) shows that estates, regardless of density, have low sustainability, except Makongeni with high sustainability due to its four housing types. This implies that density has not influenced housing diversity. The plan proposes three types of housing units in the estates, which could limit the ability to attract people of different income levels. Homogeneity in housing options can lead to economic stagnation, reducing the neighbourhoods' attractiveness [98], thereby driving gentrification. Uniform housing can exclude households that need smaller or larger units, limiting affordability and economic sustainability by excluding key workers, thereby reducing demand for local businesses and leading to concomitant displacement and social inequity [85,99]. Diverse housing will attract residents of different economic classes, reduce social segregation, maintain a stable local economy, increase demand for local services, and prevent displacement and gentrification of people, thus promoting long-term growth

and inspiring residents to preserve their property values [98,100,101]. Enhancing sustainability will require the inclusion of a wider range of housing types, especially single rooms and bedsitters, to ensure social equity and prevent the displacement of former tenants.

The plan allocates 88,106 of 130,794 units to siting tenants, which is about 67% of the proposed units across all estates, except Makongeni, which allocates about 58% of the units to siting tenants (Table S4). Table S4 presents the percentage of tenants who will be allocated houses in the renewal plan. Most residents in Eastlands live in government houses, 64% earn less than KES 24,000 per month, and are low-income earners [102]. Hence, they will receive units under the social housing programme, thereby preventing the displacement of sitting tenants. The plan proposes mixing housing units within a block to promote a stable, cohesive, and sustainable community, which aligns with UN standards [65] for providing a variety of unit sizes and tenure types to meet the housing needs of all, rather than a mono-tenure block. The tenants who will reside in a one-bedroom house will pay a monthly rent of KES 3,200; two-bedroom, KES 5,800; and three-bedroom, KES 8,200, meaning households earning KES 24,000 per month will pay 13%, 24%, and 34% of their monthly income, respectively. The National Housing Policy notes that an affordable house should not cost more than 30% of a household's monthly income, whether renting or buying [103]. Based on this threshold, the one and two-bedroom units will be affordable, and the 34% of households earning above KES 24,000 will be allowed to purchase the three-bedroom units through a tenant purchase scheme with a 25-year repayment period.

The net employment density assessment shows that medium-rise estates are less sustainable, with few job spaces, except for Kaloleni, which has medium sustainability. The low-rise estate (Shauri Moyo) has high sustainability due to its high allocation of space to businesses, given its proximity to the Nairobi central business district (CBD). The plan proposes developing a Light Industrial area at Kamukunji in Shauri Moyo estate to serve small and micro artisans operating within the estate, along with upgrading the existing Burma market and Shauri Moyo shopping centre. This shows that estates that were historically commercial nodes have been maintained as commercial hubs in the renewal plan. High-rise estates have medium-high to high sustainability, except for Mbotela, Uhuru, and Makadara, which have low sustainability because they are far from the CBD and were not designated as commercial hubs in the original plan. Concentrated employment enables the cost-effective and efficient provision of infrastructure and services, supporting sustainable urban growth [104]. The number of jobs per unit area plays a critical role in an area's economic sustainability, particularly in renewal projects where land is scarce and expensive [104]. By creating more jobs, urban renewal can limit sprawl and reduce commuting distances, thereby promoting sustainability [105]. The variations in the number of jobs per area reveal uneven economic opportunities, which can contribute to widening economic inequality among the estates. Thus, the proposed plan should create more jobs to promote economic development through vertical zoning.

The number of job assessments shows that medium-rise estates have high sustainability, with 18.9% of the area allocated to commercial and business activities. In high-rise areas, two estates have medium-high sustainability, Maringo and Makadara, with 16.1% and 15% of space allocated for commercial and business activities, respectively. Three estates have low sustainability: Mbotela, Jericho, and Uhuru, with 7%, 4.7%, and 2% of land allocated to commercial activities, respectively, which is low and limits the number of jobs and economic activities that can be created. The low-rise estate has high sustainability because 18.9% of its area is allocated to commercial and business activities, and it is closer to the CBD. A high number of job creations per 1,000 m² strengthens

economic sustainability by offering diverse employment, reduces poverty, and supports inclusive, resilient communities [106,107], thereby promoting the sustainable implementation of urban renewal plans and projects. The proposed plan should increase designated spaces for commercial activities in estates such as Jericho, Uhuru, Mbotela, and Kaloleni to foster economic opportunities and improve economic sustainability through vertical zoning, thereby meeting the floor area requirement for a mixed-use, sustainable neighbourhood of 40–60% for economic activity [66].

Population density assessment shows that medium-rise estates have high sustainability, except for Makongeni, with medium sustainability and a population density of 2057/ha. Low-rise estate has high sustainability, while high-rise estates have mixed sustainability, ranging from medium to high, except Jericho, with low sustainability due to the high population density of 3347/ha, which exceeds the [66] benchmark of about 150/ha for a sustainable neighbourhood. This shows that high population densities can become unsuitable and risky, thereby undermining environmental quality, social well-being, and service delivery, unless they are supported by strong management, adequate infrastructure, and sufficient open spaces.

Economic sustainability overall shows that Shauri Moyo has a high economic sustainability score due to its high net employment density and number of jobs, which can lead to a vibrant local economy, while Maringo estate has a medium sustainability score due to its high employment opportunities, despite attaining low social sustainability scores. This highlights the need for integrated planning that links economic growth with social improvements. High-density estates such as Makadara and Maringo will support higher job density and economic activity, but this economic gain comes with trade-offs in social and environmental conditions, which underscore the need for integrated planning that ensures environmental, social, and economic sustainability are achieved equally across estates.

Overall, sustainability shows variability across Eastlands urban renewal plan, ranging from low to medium-high. Low-rise (Shauri Moyo) has emerged as a comparatively more sustainable estate due to its location and historical legacies that influence its sustainability. Estates that perform well across sustainability criteria, economic, social, and environmental, achieve medium sustainability, while those estates with high social sustainability but low economic and environmental sustainability attain medium sustainability. This highlights the need for having a balanced development that equally addresses all sustainability criteria. The economic benefits of integrating housing diversity, population density, and employment areas increase fiscal revenue from land, promote the local economy, reduce financial cost, increase per capita disposable income, and improve land use efficiency [86].

3.5. Seeing Eastlands' urban renewal through the lens of southern urbanism theory

The Nairobi Eastlands urban renewal plan reflects southern urbanism theory, namely:

a) Shift from racial to income to income mix residential. During the colonial period, Nairobi was structured along racial residential segregation, with Eastlands established to provide affordable single dwellings for low-income African urban workers [42]. After independence, the government and employers began constructing residential units for families in Eastlands, with most of the houses developed, owned, and maintained by the Nairobi City Council (NCC) for low-income urban immigrants [51]. Eastlands, over time, deteriorated, leading to the renewal plan, which has changed the monoculture housing to mixed housing neighbourhood by proposing units of 5, 8, and 16 floors, hostels, and 1-, 2-, and 3-bedroom housing units, which will accommodate most low-income and about a third of middle-income families, with middle-income targeted for sustaining the local economy,

facilities, and services. Consequently, Eastlands will no longer be strictly low-income, but rather a mix of low- and middle-income, in line with Southern Urbanism theory, where income classes are not absolute within the same area and land uses are not segregated by income.

b) Settlement informality in low and middle-income classes. Nairobi Eastlands reflects the formal-informal housing structure generally in the global South cities. Informal settlements (largely low-income) in Kenya usually develop near high-income residential neighbourhoods [108] characterized by a lack of planning, formal housing, and inadequate provision of basic infrastructure and services. Middle-income areas also experience informalities due to ad hoc zoning practices and regularization [109,110]. Informalities are caused by fractured governance, negotiated planning, and power struggles by the housing developers and other actors that exacerbate housing informalities rather than ameliorate them [109]. This demonstrates that housing informality is not associated exclusively with low-income areas, nor absolutely tied to a specific income level, but rather by entangled rationality [109]. Thus, it is a practice that cuts across income classes, underscoring the need for mixed-income groups in an area for sustainable communities.

c) Formalization of the informal economy. Formalization of the informal economy in the Eastlands renewal plan is first achieved through the allocation of jobs and employment nodes that enable low-income earners to continue working and living within Eastlands without being displaced or destroying their livelihoods and social networks, which often sustain their informal economies. Second, the creation of markets and business nodes will provide workspaces for informal traders, thereby boosting the local economy. Third, the plan proposes a municipal market at Kaloleni and a furniture market for the micro and small entrepreneurs along Jogoo Road near Mbotela and Makongeni estates. Fourth, the plans propose increasing working spaces for formal and informal traders by expanding and densifying market areas through the provision of additional space at the Kamukunji Jua Kali business area, redesigning and improving the Gikomba open-air market, and establishing a secondary CBD at Makadara. Formalization of the informal economy is in line with the Bottom-up Economic Transformation Agenda (BETA) of the current government, which empowers marginalized groups, and is crucial for achieving sustainable and inclusive development [111,112]. The informal sector is a crucial component of economic growth, which has led the current government to develop a disruptive financial innovation model called ‘Hustler fund’ to support the informal traders [113].

d) Heritage conservation. Eastlands’ renewal plan has preserved cultural and historical areas. The key heritage sites preserved include the entire Kaloleni estate, Kariokor War Cemetery, Kariokor market, Kamkunji grounds, Burma market, and Pumwani hospital. The residences of past prominent people have also been preserved, including former president Mwai Kibaki, Prime Minister Oginga Odinga, unionist/minister Tom Mboya, and the former president of Uganda, Idi Amin. Southern urbanism suggests that heritage conservation should be through participatory processes, where residents define what is valuable and not through top-down structures that can cause displacement [114].

e) Historical legacies. Southern urbanism is fundamentally defined by historical legacies [17]. The physical and social outcomes of the renewal plan are not determined solely by contemporary planning decisions but are deeply shaped by the original design and historical legacies. Estates originally endowed with facilities and services not only retained them but also received upgrades, while those without them continued to lack them. Estates originally designed with cluster layouts and endowed with open spaces have retained and upgraded the assets under renewal, while estates designed with compact layouts without facilities have continued without them. Therefore, the renewal plan has

not corrected historical inequities but has instead reproduced them, indicating that the initial conditions led to self-reinforcing trajectories within the renewal plan.

f) Sustainability assessment in data scarcity. Limited data does not mean that an objective assessment cannot be achieved; expensive data collection is not the only way to obtain data for assessing the sustainability of plans. Therefore, objective evaluation can be achieved through secondary data, participatory evaluation, the selection of appropriate locally embedded indicators, and a flexible mix of techniques, rather than adopting techno-scientific Western models that are rarely applicable to the African city context.

4. Conclusions

Nairobi Eastlands experienced several problems that worsened over the last six decades, including deterioration and inadequacy in housing, infrastructure, environmental, and social conditions, which the proposed Nairobi Eastlands urban renewal plan (2016–2036) is meant to address. In this paper, we assessed the sustainability of the plan using selected indicators that can measure the sustainability of spatial plans based on available secondary data. The results show that neighbourhood sustainability is not influenced by density, but by design layout, historical legacies, and location. Estates with facilities in the original plan not only retained them in the renewal plan, but also received upgrades, while those without them continued without. This shows that historical inequities are perpetuated rather than addressed in the renewal plan, thereby exacerbating spatial inequalities. The gaps are not an inevitable outcome of density, but rather a product of planning decisions that can be corrected. Therefore, the plan should shift from preservation to equitable provision, from facility presence to catchment coverage, and from three-type uniformity to four-type housing diversity. Without the shift, the plan may perpetuate historical inequities, trigger displacement and gentrification, and fail to achieve equitable sustainability across Eastlands neighbourhoods. African cities, therefore, continue to perpetuate urban forms and historical legacies in urban renewal plans. The plan incorporates other sustainability strategies that are not measurable in pre-implementation assessment (waste management, carbon emission reduction, and community wellbeing), which, if implemented, will enhance the overall sustainability of Eastlands.

This paper has three limitations. First, secondary data is used without baseline data, making it difficult to determine whether the observed sustainability scores reflect improvement, stagnation, or decline. Second, the use of 12 indicators across three sustainability criteria is due to data availability. Third, we assess the proposed urban renewal plan before its implementation, but plans often change during implementation due to budget constraints, political shifts, or technical challenges. Therefore, the findings and recommendations apply to the documented plan, and researchers should evaluate implementation outcomes once the plan is executed. However, the limitations do not reduce the overall quality of the paper, as it still offers important insights into intervention measures in the renewal plan and the need for future planning research to establish baseline indicators to enable evaluation before and after plan implementation.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare that this research has no conflict of interest.

Author contributions

Sammy Letema conceptualized, framed discourse, reviewed, and edited the manuscript. Faith Mugah analysed the data and wrote the manuscript. All authors reviewed and edited the manuscript before submission for publication. All authors contributed to the article and approved the published version.

References

1. Lin SH, Huang X, Fu G, et al. (2021) Evaluating the sustainability of urban renewal projects based on a model of hybrid multiple-attribute decision-making. *Land Use Policy* 108: 105570. <https://doi.org/10.1016/j.landusepol.2021.105570>
2. Zijun YE (2019) Review of the basic theory and evaluation methods of sustainable urban renewal. *IOP Conf Ser Earth Environ Sci* 281: 012017. <https://doi.org/10.1088/1755-1315/281/1/012017>
3. Zewdie M, Worku H, Bantider A (2021) Inner city urban renewal: Assessing the sustainability and implications for urban landscape change of Addis Ababa. *J Hous Built Environ* 36: 1249–1275. <https://doi.org/10.1007/s10901-020-09797-7>
4. Chen J, Chen Y, Zhu Y, et al. (2023) Assessing the sustainability of urban community renewal projects in southern China based on a hybrid MADM approach. *Sustainability* 15: 3023. <https://doi.org/10.3390/su15043023>
5. Ibem EO, Uwakonye O, Aduwo EB (2013) An appraisal of urban renewal in Nigeria: A case study of the Nigerian Army Shopping Arena, Oshodi-Lagos. *J Place Manag Dev* 6: 155–170. <https://doi.org/10.1108/JPMD-04-2012-0014>
6. Maculan LS, Dal Moro L (2020) Strategies for inclusive urban renewal, In: *Sustainable Cities and Communities*, Cham: Springer, 662–672. https://doi.org/10.1007/978-3-319-95717-3_93
7. Zheng HW, Shen GQP, Song Y, et al. (2016) Neighborhood sustainability in urban renewal: An assessment framework. *Environ Plan B Urban Anal City Sci* 44: 903–924. <https://doi.org/10.1177/0265813516655547>
8. Toli AM, Murtagh N (2017) Environmental sustainability indicators in decision-making analysis on urban regeneration projects: The use of sustainability assessment tools, in *Proceedings of 33rd Conference on Association of Researchers in Construction Management (ARCOM)*, Cambridge, 166–175. Available from: <https://discovery.ucl.ac.uk/id/eprint/10067364>.
9. Buzási A, Csete MS (2017) Ex-ante assessment of urban development projects. *Eur J Sustain Dev* 6: 267. <https://doi.org/10.14207/ejsd.2017.v6n4p267>
10. Ge X, Qu J, Zhan X (2020) A review of the indicators for assessing the sustainability of urban regeneration, in *2020 Annual Conference on Big Data, IoT, Engineering Management (BDIEM)*, IEEE, 11–14. <https://doi.org/10.1109/BDIEM51022.2020.00009>
11. Li W, Meng M, Llewellyn CE, et al. (2024) Developing an indicator framework for sustainability assessment in urban community regeneration: A case of Shanghai. *Dev Built Environ* 18: 100476. <https://doi.org/10.1016/j.dibe.2024.100476>

12. Hemphill L, McGreal S, Berry J (2004) An indicator-based approach to measuring sustainable urban regeneration performance: Part 2, empirical evaluation and case-study analysis. *Urban Stud* 41: 757–772. <https://doi.org/10.1080/0042098042000194098>
13. Adewumi AS, Onyango V, Moyo D, et al. (2023) Conceptualising the characteristics of the indicators of a neighbourhood sustainability assessment framework in a developing country context. *Environ Impact Assess Rev* 102: 107197. <https://doi.org/10.1016/j.eiar.2023.107197>
14. Sharifi A, Dawodu A, Cheshmehzangi A (2020) Limitations in assessment methodologies of neighborhood sustainability assessment tools : A literature review. *Sustain Cities Soc* 67: 102739. <https://doi.org/10.1016/j.scs.2021.102739>
15. Onyango V, Adewumi AS (2021) Selecting indicators for assessing neighbourhood sustainability: The metropolitan lagos workflow. *Eur Sci J* 17: 170–190. <https://doi.org/10.19044/esj.2021.v17n2p170>
16. Mugah F, Letema S (2025) Sustainability assessment of residential neighbourhoods with varying densities in Nairobi, Kenya. *Discov Cities* 2: 63. <https://doi.org/10.1007/s44327-025-00101-2>
17. Afinowi T, Monkam N (2025) Advancing context-specific urban indicators for African cities: A systematic review. *npj Urban Sustain* 5: 105. <https://doi.org/10.1038/s42949-025-00292-y>
18. Schindler S (2017) Towards a paradigm of Southern urbanism. *City* 21: 47–64. <https://doi.org/10.1080/13604813.2016.1263494>
19. Wangai PW, Malonza JM, Campion BB, et al. (2025) Colonial socioeconomic segregation and intergenerational transition to sustainability of African cities, In: *Pathways to Sustainability: Collaborative Solutions for a Resilient Future*, University of Illinois Press.
20. Letema S, van Vliet B, van Lier JB (2014) Sanitation policy and spatial planning in urban East Africa: Diverging sanitation spaces and actor arrangements in Kampala and Kisumu. *Cities* 36: 1–9. <https://doi.org/10.1016/j.cities.2013.08.003>
21. Republic of Kenya (1964) National development plan 1964–1970. Available from: <https://repository.kippra.or.ke/handle/123456789/2997>.
22. Republic of Kenya (1975) Appraisal of site and service project Kenya.
23. Republic of Kenya (1984) National development plan 1984–1988. Available from: <https://repository.kippra.or.ke/handle/123456789/1429>.
24. Republic of Kenya (1970) National development plan 1970–1974. Available from: <https://repository.kippra.or.ke/handle/123456789/1421>.
25. Republic of Kenya (1989) National development plan 1989–1993.
26. Republic of Kenya (2001) National development plan, 2002–2008: Effective management for sustainable economic growth and poverty reduction. Nairobi, Kenya: Government Printer.
27. Republic of Kenya (1996) Physical planning act 1996. Kenya: Government Printer.
28. Obudho RA, Aduwo GO (1989) Slum and squatter settlements in urban centres of Kenya: Towards a planning strategy. *Netherlands J Hous Environ Res* 4: 17–29. Available from: <https://www.jstor.org/stable/43932847>.
29. Republic of Kenya (1994) National development plan 1994–1996. Government Printer.
30. UN-Habitat (2007) Kenya Slum Upgrading Programme (KENSUP).
31. Republic of Kenya (1997) *National development plan 1997–2001: Rapid industrialisation for sustained development*. Government Printer, Nairobi, Kenya.
32. MTIHUD (2019) Kenya Informal Settlements Improvement Project II (KISIP II): Vulnerable and Marginalized Groups Framework (VMGF), Nairobi, Kenya.

33. Muraguri L (2011) Kenyan government initiatives in slum upgrading. *East Afr Rev* 44: 119–127. <https://doi.org/10.4000/estafrica.534>
34. SDHUD (2023) National slum upgrading and prevention strategy 2024–2034. Nairobi, Kenya.
35. Nairobi City County (2023) Sessional paper No. 1 of 2023 on Nairobi city county development control policy.
36. Nairobi City County (2018) Urban housing renewal and regeneration policy.
37. Muraya PWK (2006) Failed top-down policies in housing: The cases of Nairobi and Santo Domingo. *Cities* 23: 121–128. <https://doi.org/10.1016/j.cities.2005.08.002>
38. Watson V (2009) Seeing from the South: Refocusing urban planning on the globe's central urban issues. *Urban Stud* 46: 2259–2275. <https://doi.org/10.1177/0042098009342598>
39. Olima WHA (2001) The dynamics and implications of sustaining urban spatial segregation in Kenya: Experiences from Nairobi metropolis. Available from: <http://hdl.handle.net/11295/55213>.
40. Oyugi MO, Onwonga GM (2024) An exploration of sustainable urban development policy for Kenya. *J Geogr Reg Plann* 17: 63–77. <https://doi.org/10.5897/JGRP2024.0868>
41. Agayi CO, Karakayacı Ö (2020) Challenges to urban housing policies implementation efforts: The case of Nairobi, Kenya. *ICONARP Int J Archit* 8: 81–101. <https://doi.org/10.15320/ICONARP.2020.144>
42. K'Akumu OA, Olima WHA (2007) The dynamics and implications of residential segregation in Nairobi. *Habitat Int* 31: 87–99. <https://doi.org/10.1016/j.habitatint.2006.04.005>
43. Veldwisch GJ, Amerasinghe P, Letema S, et al. (2024) The practices and politics of irrigated urban agriculture, *Water Int* 49: 129–143. <https://doi.org/10.1080/02508060.2024.2325800>
44. Agayi CO, Serdaroglu SN (2020) An evaluation of urban regeneration efforts in Kibera, Kenya through slum upgrading. *IDA Int Des Art J* 2: 176–192.
45. Njeri P, Munala G, Letema S (2023) Environmental sustainability performance of eleven upgraded informal settlements in Kenyan cities, *J Hous Built Environ* 38: 2751–2772. <https://doi.org/10.1007/s10901-023-10060-y>
46. K'oyoo EO (2023) Exploring and documenting urban renewal projects in Kisumu City, Kenya, with emphasis on preservation of urban landscape identity. *East Afr J Eng* 6: 188–215. <https://doi.org/10.37284/eaje.6.1.1609>
47. Hussein AM (2017) Socio-economic factors influencing community participation in the redevelopment planning of Nairobi: A case of Muthurwa and Kaloleni estates. *Afr Res J Educ Soc Sci* 4: 10–18.
48. Republic of Kenya (2015) Environmental management and co-ordination (amendment) act. Kenya: Government Printer.
49. Anderson DM (2010) Corruption at City Hall: African housing and urban development in colonial Nairobi. *Azania* 36: 138–154. <https://doi.org/10.1080/00672700109511704>
50. Githua B (2013) Rational utopias/irrational dystopias? Sites and services in Eastlands, Nairobi. *Planum J Urban* 26: 1–18.
51. Park JK (2018) Blaming the Moi era: Memories of bad governance among Eastlands residents in Nairobi, Kenya. *Mem Stud* 13: 691–707. <https://doi.org/10.1177/1750698017754247>
52. UN-HABITAT (2024) Urban regeneration for localizing the sustainable development goals development goals, Nairobi, Kenya. Available from: <https://unhabitat.org/urban-regeneration-for-localizing-the-sustainable-development-goals>.

53. He T, Hu Y, Li F, et al. (2025) An improved height sampling approach used for global urban building height mapping. *Int J Appl Earth Obs Geoinf* 141: 104633. <https://doi.org/10.1016/j.jag.2025.104633>
54. Mwaura AM (2006) Policy review for zones 3, 4 and 5, Nairobi, Kenya, in *42nd ISoCaRP Congress*, 1–13.
55. Yigitcanlar T, Kamruzzaman M, Teriman S (2015) Neighborhood sustainability assessment: Evaluating residential development sustainability in a developing country context. *Sustainability* 7: 2570–2602. <https://doi.org/10.3390/su7032570>
56. Mashrur R, Meher NN (2015) A GIS based integrated approach to measure the spatial equity of community facilities of Bangladesh. *AIMS Geosci* 1: 21–40. <https://doi.org/10.3934/geosci.2015.1.21>
57. Mugah F, Wangai P, Letema S (2025) Exploring the accessibility of amenities across three distinct residential neighbourhoods: A case study of Nairobi city, Kenya. *Proc Inst Civ Eng-U* 178: 181–193. <https://doi.org/10.1680/jurdp.24.00067>
58. Li L, Du Q, Fu R, et al. (2019) Assessing spatial accessibility to hierarchical urban parks by multi-types of travel distance in Shenzhen, China. *Int J Environ Res Public Health* 16: 1038. <http://doi.org/10.3390/ijerph16061038>
59. Barton H, Grant M, Guise R (2021) *Shaping Neighbourhoods: For Local Health and Global Sustainability*, New York: Routledge.
60. Bujang MA (2024) An elaboration on sample size determination for correlations based on effect sizes and confidence interval width: A guide for researchers. *Restor Dent Endod* 49: e21. <https://doi.org/10.5395/rde.2024.49.e21>
61. Bahadure S, Kotharkar R (2015) Assessing sustainability of mixed use neighbourhoods through residents' travel behaviour and perception: The case of Nagpur, India. *Sustainability* 7: 12164–12189. <https://doi.org/10.3390/su70912164>
62. Teriman S, *Measuring neighbourhood sustainability: A comparative analysis of residential types in Malaysia*. Ph. D. thesis, Queensland University of Technology, Brisbane, 2012.
63. Bahadure S, Kotharkar R (2018) Framework for measuring sustainability of neighbourhoods in Nagpur, India. *Build Environ* 127: 86–97. <https://doi.org/10.1016/j.buildenv.2017.10.034>
64. Lee GKL, Chan EHW (2010) Evaluation of the urban renewal projects in social dimensions. *Prop Manag* 28: 257–269. <https://doi.org/10.1108/02637471011065683>
65. Kamble T, Bahadure SP (2022) A sustainability assessment framework for population density in central Indian cities. *Int J Archit Res* 16: 134–153. <https://doi.org/10.1108/ARCH-05-2021-0142>
66. UN-Habitat (2023) My neighbourhood. Available from: <https://unhabitat.org/my-neighbourhood>.
67. Gan X, Fernandez IC, Guo J, et al. (2017) When to use what: Methods for weighting and aggregating sustainability indicators. *Ecol Indic* 81: 491–502. <https://doi.org/10.1016/j.ecolind.2017.05.068>
68. Khan AM (2020) Revisiting planning standards for open spaces in urban areas from global and national perspectives. *J Bangladesh Inst Plan* 12: 1–20. <https://doi.org/10.3329/jbip.v12i1.76775>
69. Im NH, Choi CG (2019) The hidden side of the entropy-based land-use mix index: Clarifying the relationship between pedestrian volume and land-use mix. *Urban Stud* 56: 1865–1881. <https://doi.org/10.1177/0042098018763319>
70. Xuili G, Maliene V (2021) A review of studies on sustainable urban regeneration, in *EPiC Ser Built Environ* 2: 615–625.

71. Peng Y, Lai Y, Li X, et al. (2015) An alternative model for measuring the sustainability of urban regeneration: The way forward. *J Clean Prod* 109: 76–83. <https://doi.org/10.1016/j.jclepro.2015.06.143>
72. Owuor SO, Mbatia T (2008) Post-independence development of Nairobi city, Kenya, in *Workshop on African Capital Cities*, Dakar, Senegal, 9: 22–23.
73. Githuku NK (2021) *A Tapestry of African Histories: With Longer Times and Wider Geopolitics*, Lanham: Lexington. <https://doi.org/10.5771/9781793623942>
74. Smith C (2018) Accumulating history: dirt, remains and urban decay in Nairobi. *Soc Dyn* 44: 107–127. <https://doi.org/10.1080/02533952.2018.1449493>
75. Kago J, Gateri C, K'akumu OA (2024) A growing middle class and real estate development: Spatial change and social conflicts in the densification of Kileleshwa, Nairobi. *EchoGeo* 67: 1–20. <https://doi.org/10.4000/11y07>
76. Republic of Kenya (2020) Sectional properties act. Available from: <https://new.kenyalaw.org/akn/ke/act/2020/21/eng@2022-12-31>.
77. Khamala CA (2011) Exit the rentier state: Legislating to provide affordable and secure tenure in Kenya.
78. Chan EHW (2014) Design considerations for environmental sustainability in high density development: A case study of Hong Kong. *Environ Dev Sustain* 11: 359–374. <https://doi.org/10.1007/s10668-007-9117-0>
79. Gałęcka-Drozda AJ, Szczepańska M, Wieszczyńska KA, et al. (2026) Balancing green and compact city: Assessing the quality of residential surroundings. *Cities* 168: 106421. <https://doi.org/10.1016/j.cities.2025.106421>
80. McDonald RI, Aronson MFJ, Beatley T, et al. (2023) Denser and greener cities: Green interventions to achieve both urban density and nature. *People Nat* 5: 84–102. <https://doi.org/10.1002/pan3.10423>
81. O'Driscoll C, Crowley F, Doran J, et al. (2023) Measuring land-use mixing across the Republic of Ireland: Source data comparisons. *J Maps* 19: 2214165. <https://doi.org/10.1080/17445647.2023.2214165>
82. Iannillo A, Fasolino I (2021) Land-use mix and urban sustainability: Benefits and indicators analysis. *Sustainability* 13: 13460. <https://doi.org/10.3390/su132313460>
83. Zhao X, Hu Y, Xia N, et al. (2024) Urban regeneration and SDGs assessment based on multi-source data: Practical experience from Shenzhen, China. *Ecol Indic* 165: 1112138. <https://doi.org/10.1016/j.ecolind.2024.1112138>
84. Chen J, Pellegrini P, Yang Z, et al. (2023) Strategies for sustainable urban renewal: Community-scale GIS-based analysis for densification decision making. *Sustainability* 15: 7901. <https://doi.org/10.3390/su15107901>
85. Zhu H, Gao X, Tian W, et al. (2024) Investigating the mechanisms of sustainable urban land renewal: A perspective of spatial development rights. *Sustain Cities Soc* 109: 105536. <https://doi.org/10.1016/j.scs.2024.105536>
86. Chen Y, Liu G, Zhuang T (2023) Evaluating the comprehensive benefit of urban renewal projects on the area scale: An integrated method. *Int J Environ Res Public Health* 20: 606. <https://doi.org/10.3390/ijerph20010606>
87. UITP (2018) Public transport as an instrument for urban regeneration. Available from: <https://www.uitp.org/publications/public-transport-as-an-instrument-for-urban-regeneration>.

88. Paaswell RE (2005) Mass transit: The key to urban development, urban renewal, and sustainable cities, in *CTBUH 2005 7th World Congress*, New York.
89. Talal ML, Santelmann MV (2021) Visitor access, use, and desired improvements in urban parks. *Urban For Urban Green* 63: 127216. <https://doi.org/10.1016/j.ufug.2021.127216>
90. Zhang K, Shang WL, De Vos J, et al. (2025) Illuminating the path to more equitable access to urban parks. *Sci Rep* 15: 9646. <https://doi.org/10.1038/s41598-025-94110-1>
91. Terefe AE, Hou Y (2024) Determinants influencing the accessibility and use of urban green spaces: A review of empirical evidence. *City Environ Interact* 24: 100159. <https://doi.org/10.1016/j.cacint.2024.100159>
92. Hu J, Peng C, Hu Y, et al. (2024) Accessibility evaluation and multi-scenario optimization of medical services in underdeveloped city driven by multi-source data and latest policies for China. *Sci Rep* 14: 25707. <https://doi.org/10.1038/s41598-024-76518-3>
93. Wang J, Su Y, Chen Z, et al. (2022) Assessing the spatial accessibility of urban medical facilities in multi-level and multi-period scales based on web mapping API and an improved potential model. *ISPRS Int J Geo-Inf* 11: 545. <https://doi.org/10.3390/ijgi11110545>
94. Moreno C, Gall C, Woo J, et al. (2025) Assessing accessibility of cultural sites through the 15-minute city framework in Seoul. *Int J Urban Sci* 29: 8–39. <https://doi.org/10.1080/12265934.2025.2462820>
95. Duxbury N, Hosagrahar J, Pascual J (2016) Culture lies at the heart of urban renewal and innovation. Available from: http://www.agenda21culture.net/sites/default/files/files/documents/en/culture_sd_cities_web.pdf.
96. Flores de León RM, Babere NJ, Swai O (2020) Implications of cultural heritage in urban regeneration: The CBD of Dar es Salaam. *Rev Interv Econ* 63. <https://doi.org/10.4000/interventionseconomiques.9171>
97. André I, Carmo A, Abreu A, et al. (2012) Learning for and from the city: The role of education in urban social cohesion. *Belgeo* 4. <https://doi.org/10.4000/belgeo.8587>
98. Chakraborty A, Mcmillan A (2018) Is housing diversity good for community stability? Evidence from the housing crisis. *J Plan Educ Res* 42: 150–161. <https://doi.org/10.1177/0739456X18810787>
99. Xia J, Zhao Z, Chen L, et al. (2024) How urban renewal affects the sustainable development of public spaces: trends, challenges, and opportunities. *Front Environ Sci* 12: 1482169. <https://doi.org/10.3389/fenvs.2024.1482169>
100. Ngema NN, Bokhari A, Mbanga SL (2025) Assessing the impact of social housing on urban regeneration in South African cities. *Front Sustain Cities* 7: 1468964. <https://doi.org/10.3389/frsc.2025.1468964>
101. Bai Y, Wu S, Zhang Y (2023) Exploring the key factors influencing sustainable urban renewal from the perspective of multiple stakeholders. *Sustainability* 15: 10596. <https://doi.org/10.3390/su151310596>
102. Kenya National Bureau of Statistics (KNBS) (2023) Economic Survey 2023. Nairobi, Kenya: Kenya National Bureau of Statistics.
103. Republic of Kenya (2004) Sessional paper No. 3 on national housing policy for Kenya. Available from: <https://libraryir.parliament.go.ke/handle/123456789/6117>.
104. Lee GKL, Chan HWE (2006) Effective approach to achieve sustainable urban renewal in densely populated cities, in *International CIB Student Chapters Postgraduate Conference (1st : 2006)*, Turkey.

105. Grodach C, Guerra-Tao N (2023) Industrial lands, equity, and economic diversity: A comparative study of planned employment areas in Melbourne, Australia. *Urban Res Pract* 16: 689–705. <https://doi.org/10.1080/17535069.2022.2080583>
106. Keivani R, Tah JHM, Kurul E, et al. (2010) *Green Jobs Creation Through Sustainable Refurbishment in the Developing Countries*, Geneva: ILO.
107. Thwala WD (2009) Sustainable development through urban renewal projects: A case of Johannesburg, South Africa, in *2009 Conference on green building towards eco-city*.
108. Jimmy EN, Martinez J, Verplanke J (2020) Spatial patterns of residential fragmentation and quality of life in Nairobi city, Kenya. *Appl Res Qual Life* 15: 1493–1517. <https://doi.org/10.1007/s11482-019-09739-8>
109. Jimmy EN, Lombard M (2024) Entangled rationalities: Planning responses to informal housing practices within middle-income neighbourhoods in Nairobi City, Kenya. *Plan Theory Pract* 25: 299–320. <https://doi.org/10.1080/14649357.2024.2393572>
110. Ambani MM, Wamuchiru E, Ayonga JN, et al. (2024) Relaxation of plot ratio and lot size and the triggering of gentrification in the industrial area of Nairobi. *Africa Habitat Rev* 19: 3046–3060. <https://doi.org/10.66563/mv9ahb37>
111. Achuti EO (2026) The bottom up economic model and the development agenda in Kenya: A systematic review and future directions. *J Bus Econ Dev* 11: 40–58. <https://doi.org/10.11648/j.jbed.20261102.11>
112. Republic of Kenya (2024) Fourth medium term plan 2023–2027: Bottom-up economic transformation agenda for inclusive growth, Nairobi: The National Treasury and Economic Planning.
113. Beatrice K, Wangonde W, Muathe S (2023) Hustlers’ fund: A disruptive model in the financial context in Kenya: Review of literature. *Int J Soc Sci Econ Res* 4: 650–666. <https://doi.org/10.46609/IJSSER.2023.v08i04.007>
114. Nyamu G (2026) Reframing sustainability in East African cities: Community perspectives in the built environment. *Africa Habitat Rev* 21: 3714–3727. <https://doi.org/10.66563/7m8a8443>



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