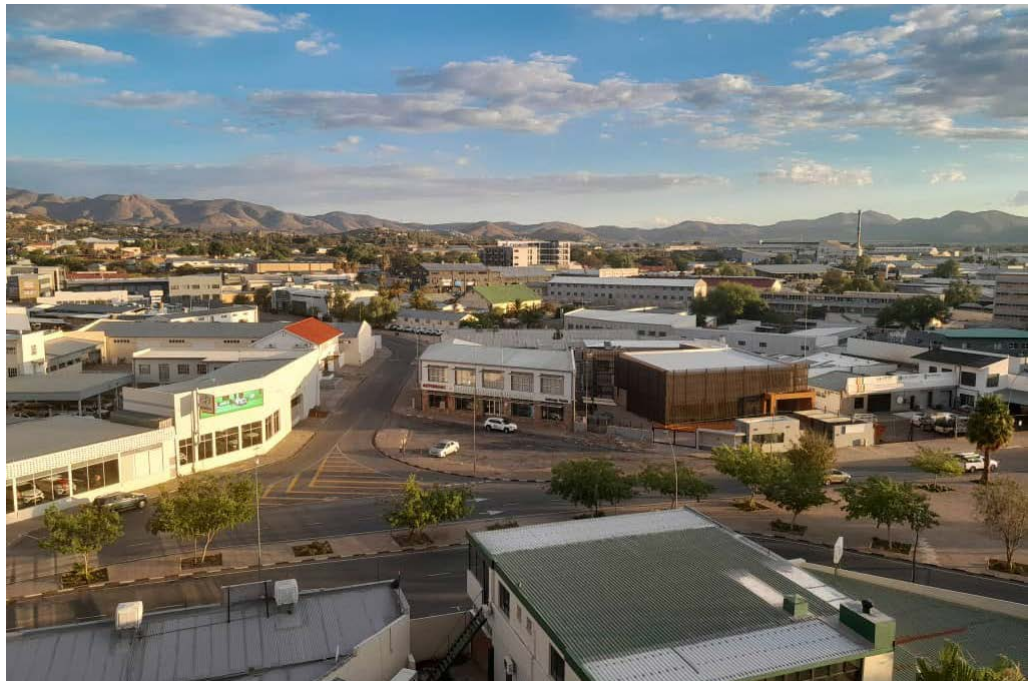
PHYSICAL PLANNING AND RESIDENTIAL LIVEABILITY: A GREEN INFRASTRUCTURE PATHWAY FOR RESILIENCE AND QUALITY OF LIFE

By Eric Yankson



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1. INTRODUCTION

The evaluation of residential liveability within the ambit of physical planning is pivotal for assessing quality of life. While this subject is important for understanding the lived experiences of residents in developing countries, much of the existing research appears to be mostly focused on cities in North America and Europe. Within the sub-Saharan African context, an analysis of residential liveability speaks to broader structural issues such as the state of the planning system and socio-spatial inequities. This research thus seeks to contribute by analysing residential liveability within the lens of physical planning in Windhoek, a city in Namibia (Southern Africa). Specifically, it employs a green infrastructure framework with the goal of assessing implications for urban resilience and quality of life.

Adopting a green infrastructure approach for evaluating residential liveability is important given its obvious implications for the attainment of the United Nations Sustainable Development Goals which have become a topical research agenda across nations in both the developed and developing worlds (Lange Salvia, Leal Filho, Brandli & Griebler, 2019; Saxena, Ramaswamy, Beale, Marciniuk & Smith, 2021). Besides, gaps can be identified in the existing discourse on residential liveability and green infrastructure. These include a relatively greater focus on temperate regions, to the virtual exclusion of the tropical areas in the developing world where much of the urbanisation process is taking place (Botzat, Fischer & Kowarik, 2016, pp. 220-222). There is also a bias in favour of large forests and parks while less formal spaces such as wastelands have attracted less attention. Moreover, biodiversity research appears to be more focused on ecosystems with less emphasis on what happens at the community or gene level. Additionally, the socio-economic and demographic diversity of residents has been relatively less broached (Botzat et al., 2016, pp. 220-222).

This research seeks to address existing gaps in the literature by examining residential liveability in a sub-Saharan African urban context based on a green infrastructure approach. The ultimate goal is to assess implications for resilience and quality of life. I start the discussion by reviewing relevant literature on the key terms used in the study. I also talk about the research design, objectives and questions. I then discuss the results of the Windhoek survey before proposing a green infrastructure index. Finally, I assess ramifications for urban resilience and quality of life before concluding the paper.

2. PHYSICAL PLANNING, RESIDENTIAL LIVEABILITY AND GREEN INFRASTRUCTURE

Physical planning involves the judicious use of land to meet both current and future needs. The concept may also be referred to as land use planning, spatial planning or town and country planning. Physical planning entails the effective integration of economic, social and ecological factors within the ambit of the political context to ensure a sustainable management of resources for development (Akanbang, Ibrahim & Yakubu, 2021, p. 2). The concept can either spur physical development or exist because of physical development. Thus, it serves as the framework for the regulation of urban design, growth management and land use. Physical planning is inherently linked with land administration and thus defines tenure rights, responsibilities and community participation (Akanbang et al., 2021, p. 2). Within the lens of modernism, physical planning entails a universal approach to urban design, building codes and development control. This may however be at variance with local conditions, thus creating the need for a postmodern approach which is more attuned with diversity and local context (Molebatsi & Morobolo, 2021, pp. 134-135).

Physical planning is inherently linked with residential liveability. The concept of liveability entails the satisfaction of residents with existing conditions in the environment within which they reside. This may be

based on attributes in the natural and built environments (Kovacs-Györi & Cabrera-Barona, 2019a, p. 1; Ruth & Franklin, 2014, p. 18). Moreover, it embodies interactions between the individual and the physical environment. These may be delineated in terms of spatial characteristics or the ability to address the needs of residents (Kovacs-Györi & Cabrera-Barona, 2019, pp. 1-2). Thus, liveability may first be assessed based on the needs of residents with respect to shelter, sanitation, health, recreation and other services (Ruth & Franklin, 2014, p. 18). Moreover, factors such as biophysical elements, urban morphology, accessibility and housing conditions can shape liveability (Kovacs-Györi, Cabrera-Barona, Resch, Mehaffy & Blaschke, 2019, p. 20). Beyond these foundational concepts, liveability may also be extended to encompass human well-being, as well as advancements in the social and ecological environments (Ruth & Franklin, 2014, p. 19).

Residential liveability is inherently associated with urban green infrastructure. Green infrastructure comprises an interlinked system of natural and semi-natural attributes such as green spaces and water bodies which straddle territorial domains. The management of these infrastructure entails contested interests across different spatial domains (Mell, 2018, pp. 290-291, 308-312). According to Benedict and McMahon (2006, p. 12), the term refers to "an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife". While green infrastructure was originally conceived primarily in terms of the natural environment, its meaning has since been broadened to encompass the built environment and the social context associated with this. As a result, it embodies human technology and the concomitant engineered systems which define the physical environment. Green infrastructure thus entails an interconnected system of the natural and built environments towards enhanced residential quality of life (Young, Zanders, Lieberknecht & Fassman-Beck, 2014, pp. 2571-2572).

3. URBAN RESILIENCE AND QUALITY OF LIFE

Physical panning, residential liveability and green infrastructure have direct implications for urban resilience and quality of life. Resilience refers to the ability of a system which has been exposed to a shock or disturbance to recover or survive. This may be in terms of scarcity of resources or climate change impacts (Dodman, Diep & Colenbrander, 2017, p. 98). The concept could thus portend the need for better conservation of natural resources. Urban resilience may be assessed in terms of the multifunctionality and connectivity associated with urban green infrastructure. Multifunctionality entails flexibility and adaptability in the green ecosystem which results in better responses to uncertainty (Liu, Xiu & Ye, 2020, pp. 1-2). Connectivity is important for ensuring a better functioning and coherent urban system which forestalls the challenges posed by spatial fragmentation. Two types can be identified namely structural and functional connectivity. Structural connectivity refers to physical inter-linkages in the urban green infrastructure. Functional connectivity entails how humans interact with the physical environment (Liu et al., 2020, pp. 1-2).
The promotion of resilience towards enhanced quality of life can also occur through the adoption of green infrastructure approaches to mitigate effects of urban sprawl such as intensified land use, pollution and loss of the vegetation cover. This may comprise the increased integration of various urban land uses, as well as institutions and local communities to ensure better environmental adaptation. Ultimately, this entails conceptualisation of the urban system as a polycentric framework which facilitates economic linkages and ensures sufficient supply of natural resources for human subsistence (Vargas-Hernández & Zdunek-Wielgolaska, 2021, pp. 1335, 1348-1349).

Urban resilience and quality of life may portend resource efficiency and green investments. The concept of resource efficiency entails a more prudent utilisation of natural endowments to maximise benefits and minimise waste. This may involve using the same amount of investments to generate more outputs or producing the same level of output with less resource commitments (Dodman et al., 2017, p. 99; Leal Filho et al., 2019). Green investment entails strategic commitments towards the reduction of pollution and greenhouse gas emissions without necessarily upending the existing production and consumption of ecological resources (Eyraud, Clements & Wane, 2013, p. 853).

4. CONTEXTUALISING PHYSICAL PLANNING AND RESIDENTIAL LIVEABILITY IN AFRICA

In this section, I seek to contextualise the discourse on physical planning and residential liveability for sub-Saharan Africa in order to provide a better comprehension for the rest of my discussion. I observe that the urban planning system in colonial Africa resulted in the prioritisation of modernist planning, as opposed to the incorporation of socio-cultural perspectives in the planning process (Cobbinah & Darkwah, 2017, pp. 269-271). Even in the postcolonial eon, the piecemeal nature of government interventions coupled with the overreliance on international development assistance imply that practices such as colonial era master planning remain dominant (Cobbinah & Darkwah, 2017, pp. 271-281). With specific reference to the Namibian context, urban planning prior to independence in 1990 was based on an apartheid system which resulted in the institutionalisation of residential segregation (Müeller-Friedmann, 2006, pp. 34-37). Even in the post-independence era, monofunctional urban forms characterised by socio-spatial disparities are still common (Müeller-Friedmann, 2006, pp. 34-37).

The planning and policy contexts for the promotion of residential liveability in Namibia may be broadly assessed within the lenses of Vision 2030, the National Development Plans, Harambee Prosperity Plan, as well as the Urban and Regional Planning Act of 2018. Vision 2030 constitutes the broad-based development framework for the country. It aims to ensure

national prosperity through enhanced quality of life, social equity, wealth creation and livelihoods. Moreover, the national development plans seek to attain defined socio-economic targets in five-year cycles premised on pillars such as economic progression, social transformation, environmental sustainability and good governance. Additionally, the Harambee Prosperity Plan is a targeted approach to ensure national development in priority intervention areas such as effective governance, economic advancement, social progression, as well as infrastructural development. With specific reference to cities, the Urban and Regional Planning Act of 2018 shapes residential liveability by defining the modalities for the preparation, approval and review of structure plans, zoning schemes and townships. It also articulates the rules for land management in terms of subdivision, consolidation, as well changes in conditions for its use.

5. RESEARCH DESIGN, OBJECTIVES AND QUESTIONS

This study is based on a pragmatic and postmodern research design. Pragmatism stresses the salience of research as a tool for generating practical consequences for society. It seeks to forestall the challenges associated with constructivism and post-positivism by focusing on what works. As a result, it is particularly suited to mixed methods of enquiry since it argues that qualitative and quantitative approaches are not significantly different within ontological or epistemological frames (Feilzer, 2010, pp. 7-9). This study seeks to make observations and recommendations on how residential liveability can be improved through green infrastructure.

Besides pragmatism, postmodernism seeks to move away from the previous dispensation of modernism which was fixated with the creation of a more orderly urban landscape with little or no cognisance for the social context within which physical planning occurs. It thus acknowledges the plurality of the urban space as configured by participatory planning, diversity and spatial fragmentation (McGreevy, 2018, pp. 359-362). Specifically, the evaluation of residential liveability based on both natural and man-made attributes, as well as residents' perceptions speak to the contextual nature of the analysis.

This study primarily adopts qualitative approaches, albeit supplemented with quantitative techniques, to achieve its objectives. The qualitative technique utilises interviews with residents, as well as personal observations of the neighbourhoods of focus. The research is also based on a case study design. The case study approach serves to provide an in-depth examination of phenomena of interest by a researcher. This helps to assess the socio-spatial elements which explain noted observations. Given the delimitations of a specific area of focus, a case study also scales down the scope of analysis to a manageable level given available resources such as time and money.

Moreover, the quantitative approach entails the use of questionnaires to obtain the perspectives of participants on liveability in the city. Also, it employed a statistical sampling approach to select respondents for this study. Specifically, the research utilised non-random quota, purposive and convenience sampling. The non-random approach entailed interviewing or administering questionnaires to respondents based on their eligibility to participate in the study. To ensure a fairly representative sample, the researcher selected residents from a variety of neighbourhoods. These included: upscale areas (Ausspannplatz and Pioneer's Park); middle-income locales (Windhoek North and Dorado Park); as well as low end neighbourhoods (Katutura and Wanaheda). Overall, a total of 128 respondents were included in the study with the following breakdown: Ausspannplatz (22); Pioneer's Park (17); Windhoek North (20); Dorado Park (25); Katutura (22); Wanaheda (12); and miscellaneous (10).

The specific objectives of the study include: to assess resident perceptions regarding liveability in their neighbourhoods; to propose and apply a green infrastructure framework for residential liveability; and to analyse the implications of liveability for urban resilience and quality of life. The research questions are as follows: How do the residents of Windhoek feel regarding the state of liveability in their neighbourhoods? How do these residents conceptualise liveability and what suggestions do they have for making their locales more habitable? What are the defining parameters or elements of a green infrastructure index for residential liveability? What are the ramifications of residential liveability for urban resilience and quality of life?

6. WINDHOEK SURVEY RESULTS

In this section, I present the results of the Windhoek survey before discussing them within the lens of the proposed green infrastructure index. The survey revealed that 78.1% of respondents described themselves as residents who care about the environment while 3.9% indicated that they were indifferent about the environment. When asked about the level of importance they attach to the physical environment, residents indicated the following responses: very important (74.2%); important (21.1%); and fairly important (4.7%). Specifically, they provided several reasons to explain why the environment is important to them. These included the promotion of health, amenity and safety. Some respondents indicated that a clean environment ensures a high quality of life through clean air, sanitation and infrastructure. Many residents also indicated the importance of the resources available in the environment to their day-to-living. Also, the environment is crucial to enhanced beautification of the city and increased accessibility to places.

Survey respondents observed various aspects of the physical environment which could be found in their neighbourhoods. For instance, 63.3% of them noted the presence of parks, while 74.2% indicated the availability of trees or forests. Also, 34.4% of residents articulated the presence of highlands, while 43% observed the predominance of lowlands. Moreover, 31.3% of participants indicated the availability of water bodies, while

67.2% apprised the existence of drainage systems. In terms of sanitation, 72.7% of respondents observed the presence of waste disposal sites. With respect to the built environment, 89.8% of residents noted the availability of roads while 74.2% observed the presence of amenities such as shopping malls. Also, 82% of participants noted the presence of buildings and 78.9% indicated streets or public squares. Additionally, 69.5% of residents observed the existence of signages while 22.7% noted the presence of landmarks. Survey respondents who answered the question regarding their perceptions about the state of their physical environments made various observations ranging from excellent to poor (Table 1).

TABLE 1: RESIDENT PERCEPTIONS OF THE STATE OF THE PHYSICAL ENVIRONMENT

Aspect of Physical Environment	Condition of Physical Environment					
	Excellent	Good	Average	Poor	Very Poor	Not Answered
Parks	16 (12.5%)	29(22.7%)	34 (26.6%)	16 (12.5%)	0 (0%)	26 (20.3%)
Trees/Forests	9 (7%)	56 (43.8%)	32 (25%)	13 (10.2%)	0 (0%)	16 (12.5%)
Highlands	6 (4.7%)	20 (15.6%)	21 (16.4%)	11 (8.6%)	0 (0%)	62 (48.4%)
Lowlands	5 (3.9%)	31 (24.2%)	24 (18.8%)	8 (6.3%)	0 (0%)	47 (36.7%)
Water bodies (e.g. river beds, streams etc.)	6 (4.7%)	11 (8.6%)	21 (16.4%)	20 (15.6%)	0 (0%)	58 (45.6%)
Drainage systems	13 (10.2%)	45 (35.2%)	23 (18%)	15 (11.7%)	0 (0%)	29 (22.7%)
Waste disposal sites (e.g. dustbins, landfills etc.)	23 (18%)	41 (32%)	29 (22.7%)	11 (8.6%)	0 (0%)	17 (13.3%)
Roads	37 (28.9%)	51 (39.8%)	19 (14.8%)	10 (7.8%)	0 (0%)	10 (7.8%)
Pavements/ Sidewalks	38 (29.7%)	42 (32.8%)	22 (17.2%)	5 (3.9%)	0 (0%)	17 (13.3%)
Amenities (e.g. schools, hospitals, shopping malls etc.)	28 (21.9%)	46 (35.9%)	24 (18.8%)	5 (3.9%)	0 (0%)	18 (14.1%)
Buildings (e.g. houses, public buildings etc.)	27 (21.1%)	56 (43.8%)	22 (17.2%)	3 (2.3%)	0 (0%)	17 (13.3%)
Streets/ Public squares	29 (22.7%)	51 (39.8%)	24 (18.8%)	5 (3.9%)	0 (0%)	17 (13.3%)
Signage (e.g. road signs, billboards etc.)	31 (24.2%)	44 (34.4%)	18 (14.1%)	5 (3.9%)	0 (0%)	25 (19.5%)
Landmarks (e.g. statues, cultural attractions, tourist sites etc.)	9 (7%)	17 (13.3%)	8 (6.3%)	7 (5.5%)	0 (0%)	66 (51.6%)

Source: Author's construct based on Windhoek survey

Residents provided various responses when they were asked what their understanding of liveability was. For instance, 63.3% of respondents defined the concept in terms of well-maintained parks while 60.2% referred to it as the presence of well-conserved trees or forests. Only 16.4% of participants defined liveability in terms of the existence of scenic highlands and 39.1% conceptualised it as presence of habitable lowlands. However, as much as 71.1% of respondents opined that liveability entails the presence of clean water bodies while 66.4% averred it referred to the existence of proper drainage systems. Also, 67.2% of residents noted it entailed the presence of proper waste disposal sites and 70.3% indicated accessible road networks as the embodiment of liveability. Additionally, 59.4% of participants articulated the concept in terms of the existence of well-maintained pavements while 68.8% respectively noted the presence of user-friendly amenities and well-maintained buildings. Respondents articulated liveability in the following other ways: safe streets or public squares (69.5%); easy-to-read signages (62.5%); and beautiful landmarks (46.1%).

When asked whether the state of their physical environment promotes liveability, residents provided the following affirmative responses for the various aspects of their environments: parks (59.4%); trees or forests (64.1%); highlands (22.7%); lowlands (39.1%); water bodies (28.9%); drainage systems (65.6%); waste disposal sites (67.2%); roads (81.3%); pavements (74.2%); amenities (72.7%); buildings (72.7%); streets or public squares (68%); signages (64.1%); and landmarks (27.3%).

Residents made both positive and negative observations when they were asked about the changes they have seen in their environment over the years when it comes to liveability. On the positive side, some respondents observed that their environments were becoming more hygienic with parks being built or redesigned. Others indicated that parks, trees, water bodies and drainage systems were being well-maintained. Respondents also lauded the existence of cleaning campaigns, construction of proper roads and presence of easy-to-read signages. On the negative side, some residents lamented that parks were becoming less clean with more dry vegetation. Moreover, they observed de-vegetation as a major problem. Other respondents noted that riverbeds were drying up and had become dirtier or bushy over time. Some residents bemoaned the presence of blocked drainage systems with bad odour, overflowing dustbins and cracks or potholes in their roads. Also, other respondents noted the existence of old or poorly maintained amenities and buildings. They observed that streets or public squares were becoming dirtier over time. Other residents bemoaned the presence of few road signs.

Survey respondents made a few recommendations for improving liveability in their neighbourhoods. The included the establishment of new parks as well as cleaning and maintenance of existing parks. Others called for the parks to be made more user-friendly especially through the provision of more facilities for children. Respondents also called for greater protection of the environment by preventing the cutting down of existing trees and planting new ones. They articulated the need for better environmental awareness. Some participants called for the establishment of water points and pit latrines in their neighbourhoods. They underscored the need to clean or maintain water bodies and drainage systems. In terms of sanitation, respondents recommended the provision of more dustbins for waste collection and the upgrading of service delivery. As regards the built environment, residents intimated the need to construct new roads and

maintain existing ones. They also underscored the importance of creating more pavements for pedestrians and maintaining existing ones. Moreover, participants noted that amenities and buildings must be renovated. They stressed the need to keep streets clean and ensure better safety by providing streetlights and cameras. Residents also intimated that more signages such as billboards and road signs must be provided at vantage points. In terms of landmarks, they underscored the need to invest more in facilities such as arts and cultural centres as well as places of historical significance as a way of attracting more tourists.

7. PROPOSED GREEN INFRASTRUCTURE INDEX

This section proposes a green infrastructure index for residential liveability. While the proposed index was primarily designed with Windhoek in mind, it may have applications for other African cities even though some modifications could be required to account for the nuances of specific cities. The proposed index assigns values of 5 to 1 for each parameter to evaluate its liveability ranking (where 5 = very high liveability; 4 = high liveability; and 3 = moderate liveability; 2 = low liveability; and 1 = very low liveability). Based on the indicated rankings, very high liveability has a total score of 70, while high liveability equals 56. Also, moderate liveability ranks 42 in total. Moreover, low liveability totals 28 and very low liveability equals 14 (Table 2).

TABLE 2: PROPOSED GREEN INFRASTRUCTURE INDEX FOR RESIDENTIAL LIVEABILITY

Aspects of Physical Environment	Very High Liveability	High Liveability	Moderate Liveability	Low Liveability	Very Low Liveability
Parks	5	4	3	2	1
Trees/Forests	5	4	3	2	1
Highlands	5	4	3	2	1
Lowlands	5	4	3	2	1
Water bodies (e.g. riverbeds, streams etc.)	5	4	3	2	1
Drainage systems	5	4	3	2	1
Waste disposal sites (e.g. dustbins, landfills etc.)	5	4	3	2	1
Roads	5	4	3	2	1
Pavements/ Sidewalks	5	4	3	2	1
Amenities (e.g. schools, hospitals, shopping malls etc.)	5	4	3	2	1
Buildings (e.g. houses, public buildings etc.)	5	4	3	2	1
Streets/ Public squares	5	4	3	2	1
Signage (e.g. road signs, billboards etc.)	5	4	3	2	1
Landmarks (e.g. statues, cultural attractions, tourist sites etc.)	5	4	3	2	1
Total Liveability Score	70	56	42	28	14

The rankings for Windhoek are based on the survey responses for each of the options regarding residents' perceptions on the state of the physical environment i.e. excellent, good, average, poor and very poor. Thus, the response of excellent corresponds with a ranking of 5; good equals 4; average is 3; poor equals 2; and very poor is equivalent to 1. When rankings were subjectively assigned (based on which option i.e. excellent, good, average, poor, or very poor, received the most responses for each liveability indicator) without any weightings, a total score of 53 was generated for the liveability of Windhoek. This figure means the city's liveability ranking as per the resident perceptions ranges between moderate and high (Table 3).

TABLE 3: NON-WEIGHTED SUBJECTIVE LIVEABILITY RANKINGS FOR WINDHOEK

Aspects of Physical Environment	Overall Windhoek Liveability Ranking Based on Resident Perceptions
Parks	3
Trees/Forests	4
Highlands	3
Lowlands	4
Water bodies (e.g. river beds, streams etc.)	3
Drainage systems	4
Waste disposal sites (e.g. dustbins, landfills etc.)	4
Roads	4
Pavements/ Sidewalks	4
Amenities (e.g. schools, hospitals, shopping malls etc.)	4
Buildings (e.g. houses, public buildings etc.)	4
Streets/ Public squares	4
Signage (e.g. road signs, billboards etc.)	4
Landmarks (e.g. statues, cultural attractions, tourist sites etc.)	4
Total Liveability Score	53

Source: Author's construct based on Windhoek survey

To ensure a more nuanced analysis, each ranking was individually multiplied with a weighting equal to the percentage of respondents who chose that option. A few limitations associated with this approach must be noted. To begin with, not all respondents answered the questions about the state of their physical environment. Thus, the rankings generated are based only on the answered options (since the non-answers were assigned a value of 0 and thus excluded from the analysis). The overall ranking scores may therefore not necessarily be representative of the perspectives of the entire population. This notwithstanding, they provide an important first-hand picture of how resident perceptions help us to evaluate liveability. When weightings were assigned for all respondents, a figure of 37.328 which ranges between moderate and low liveability was obtained (Table

4). The various ranges obtained appear to suggest a nuanced picture of the liveability situation in the city. While the high ranking is commensurate with widely held perceptions about the pristine nature of the city for human habitation, the moderate and low aspects indicate there is room for improvement.

TABLE 4: WEIGHTED LIVEABILITY RANKINGS FOR WINDHOEK

Aspects of Physical Environment	Very High Liveability	High Liveability	Moderate Liveability	Low Liveability	Very Low Liveability	Overall Windhoek Liveability Ranking
Parks	5*12.5% =0.625	4*22.7% =0.908	3*26.6% =0.798	2*12.5% =0.25	1*0% =0	2.581
Trees/Forests	5*7% =0.35	4*43.8% =1.752	3*25% =0.75	2*10.2% =0.204	1*0% =0	3.056
Highlands	5*4.7% =0.235	4*15.6% =0.624	3*16.4% =0.492	2*8.6% =0.172	1*0% =0	1.523
Lowlands	5*3.9% =0.195	4*24.2% =0.968	3*18.8% =0.564	2*6.3% =0.126	1*0% =0	1.853
Water bodies (e.g. river beds, streams etc.)	5*4.7% =0.235	4*8.6% =0.344	3*16.4% =0.492	2*15.6% =0.312	1*0% =0	1.383
Drainage systems	5*10.2% =0.51	4*35.2% =1.408	3*18% =0.54	2*11.7% =0.234	1*0% =0	2.692
Waste disposal sites (e.g. dustbins, landfills etc.)	5*18% =0.9	4*32% =1.28	3*22.7% =0.681	2*8.6% =0.172	1*0% =0	3.033
Roads	5*28.9% =1.445	4*39.8% =1.592	3*14.8% =0.444	2*7.8% =0.156	1*0% =0	3.637
Pavements/ Sidewalks	5*29.7% =1.485	4*32.8% =1.312	3*17.2% =0.516	2*3.9% =0.078	1*0% =0	3.391
Amenities (e.g. schools, hospitals, shopping malls etc.)	5*21.9% =1.095	4*35.9% =1.436	3*18.8% =0.564	2*3.9% =0.078	1*0% =0	3.173
Buildings (e.g. houses, public buildings etc.)	5*21.1% =1.055	4*43.8% =1.752	3*17.2% =0.516	2*2.3% =0.046	1*0% =0	3.369
Streets/ Public squares	5*22.7% =1.135	4*39.8% =1.592	3*18.8% =0.564	2*3.9% =0.078	W*0% =0	3.369
Signage (e.g. road signs, billboards etc.)	5*24.2% =1.21	4*34.4% =1.376	3*14.1% =0.423	2*3.9% =0.078	1*0% =0	3.087
Landmarks (e.g. statues, cultural attractions, tourist sites etc.)	5*7% =0.35	4*13.3% =0.532	3*6.3% =0.189	2*5.5% =0.11	1*0% =0	1.181
Total Liveability Score						**37.328**

8. LIVEABILITY IMPLICATIONS FOR URBAN RESILIENCE AND QUALITY OF LIFE

Resident perceptions from the Windhoek survey emphasise the salience of both natural and man-made aspects of the physical environment to the promotion of liveability. Thus, while the physical environment appears buoyant to increased human demand, there is the need for concerted efforts towards prudent use to prevent a state of disrepair. The Windhoek town planning scheme therefore underscores the need for conservation of natural resources through the growing of trees on designated erven. It also stresses that no building structures shall be erected/altered or refuse dumped in a way which pollutes groundwater resources. Moreover, it articulates the need to protect low gradient areas which serve as sources of water bodies. Evidently, strategic investments in these infrastructures by municipal authorities and national government are important for maintaining ecological integrity and ensuring a certain basic quality of life.

Moreover, resident insights from the Windhoek survey reveal the need for novel or alternative approaches to the protection of the environment as a way of addressing issues when they arise. Currently, the predominant approaches for ensuring this appears to be through administrative environmental regulation at both the national and municipal levels. Specifically, the Urban and Regional Planning Act of 2018, the Windhoek Transformational Strategic Plan for 2017-2022, as well as the town planning scheme come to mind. Going forward, more participatory planning approaches can be envisaged in order to effectively incorporate resident inputs in the environmental management process.

In terms of urban resilience and quality of life, the prudent utilisation of the natural environment portends resource efficiency in consumption as it results in the minimisation of negative ecological impacts. To begin with, environmental protection as a component of residential liveability entails the maintenance of green spaces such as parks, trees and forests. It also involves the protection of water bodies and proper drainage systems. Moreover, the presence of proper waste disposal sites promotes liveability by improving sanitation and by extension public health. Additionally, it creates better amenity value by avoiding unsightly physical environments laden with human or material waste products.

As regards the built environment, the presence of accessible road networks and well-maintained pavements ensure resilience and improved quality of life through a new urbanism approach. Specifically, it enhances commuting within and between neighbourhoods. Moreover, the presence of sidewalks promotes walkability thus minimising the ecological damage associated with motorised forms of transport. Also, the existence of user-friendly amenities such as schools, hospitals and shopping malls enhances access to public service delivery. Additionally, the presence of well-maintained buildings is associated with structural integrity and thus the safety of the general public. The existence of safe streets/public squares speaks to the

welfare of the general public and their protection from crime. The use of signages and landmarks also promotes easy identification or location of places making it easy for residents or visitors to navigate around the city.

9. CONCLUSION

Overall, the findings of the exploratory liveability analysis for Windhoek within a green infrastructure lens may be summarised as follows:

Concepts	Details
Green infrastructure parameters	Natural environment: parks, trees/forests, highlands, lowlands and water bodies. Man-made environment: drainage systems, waste disposal sites, roads, pavements/sidewalks, amenities, buildings, streets/public squares, signages and landmarks.
Analytical paradigm	Resident perceptions on the condition of the physical environment
Total possible liveability scores	Very high liveability: 70, High liveability: 56, Moderate liveability: 42, Low liveability: 28, Very low liveability: 14
Non-weighted measure for green infrastructure index	Subjective liveability: 53 (ranges between moderate and high liveability)
Nuanced measure for green infrastructure index	Weighted liveability: 37.328 (ranges between moderate and low liveability)

This study contributes to existing scholarship by establishing conceptual relationships between residential liveability and green infrastructure in a sub-Saharan African context. Specifically, the inter-linkages were analysed through the proposed conceptual framework which elucidated the urban resilience and quality of life implications of residential liveability. The approach is pivotal for the essentialisation of liveability as a construct which contributes to enhance human well-being through the lived experiences of residents. Overall, liveability is associated with attributes such as amenity value and less ecological impact, which are enshrined in the ethos of greenness. Green infrastructure may also be regarded as the pivot of residential liveability since it entails the allocation of resources to improve natural and man-made features towards betterment of neighbourhoods and communities.

With reference to sub-Saharan Africa, this analysis bridges a critical gap in the extant discourse given the relative dominance of research from places such as North America and Europe. The African context of residential liveability and green infrastructure evince the roles of local or national authorities in reversing historical tides of socio-spatial inequities and development pursuits which placed less emphasis on the ecological imperative. In specific terms, the analysis is useful for dissecting the lived experiences of residents in Windhoek which has not received much attention in the existing literature. Future studies could apply the proposed green infrastructure approach to the evaluation of residential liveability in other cities within Africa and elsewhere in the developing world.

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