Sustainable Urban Futures: Assessing the Applicability of the Urban Harvest Approach in Uganda

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Abstract

Urbanization is transforming cities around the world at an unprecedented pace, raising questions about sustainability and resource management. As urban populations grow, the need for innovative approaches to ensure environmental and economic stability has become more pressing than ever. This research examines the incorporation of the Urban Harvest Approach (UHA) into Ugandan policies and regulations to promote sustainable urban development. Through a thematic policy analysis of key documents ranging from Uganda's foundational Vision 2040 to more recent frameworks, four overarching themes emerge; economic sustainability, environmental sustainability, policy and governance, and climate change mitigation and adaptation. Economic sustainability efforts focus on stimulating sustainable economic growth while leveraging indigenous resources. Environmental sustainability initiatives prioritize sustainable land management and conservation, yet challenges persist in waste management. Policy and governance strategies emphasize green policies, although challenges like limited institutional capacity hinder the effective implementation of UHA principles. Climate change mitigation and adaptation strategies prioritize renewable energy promotion and water resource management but face constraints such as limited resources. While Uganda exhibits dedication to sustainable development, challenges exist in fully operationalizing UHA principles within current policies. Bridging this gap between policy formulation and implementation is essential for advancing sustainable development goals, and further research on UHA implementation and its practical challenges can inform policy adjustments and interventions to advance Uganda's sustainable development objectives.

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1. Introduction

Urban areas will be home to over two-thirds of the global population by 2050 [1]. The African continent, in particular, is witnessing a profound urban transition, with projections indicating a threefold increase in the urban population from 395 million in 2010 to 1.339 billion in 2050, accounting for about 21% of the world's projected urban population [2]. As urbanization accelerates, cities become centers of economic activity and population density, significantly altering the landscape and driving environmental change [3]. The unprecedented growth of African urban areas raises questions about the sustainability of urban living, resource management, and their capacity to ensure the well-being of their inhabitants. Sustainable Development Goal (SDG) 11 addresses these concerns, focusing on creating cities that are inclusive, resilient, and sustainable [4], essential for fostering the transition towards a circular economy.

The rapid growth of cities has made them increasingly dependent on their hinterlands for the import of essential resources and waste disposal [5]. Urbanization, coupled with additional pressures imposed on cities such as climate change, resource depletion, and pollution indicates the need for integration of sustainable resource management and spatial planning to create more self-sufficient and resilient cities [6] in line with SDG 12's emphasis on the transition towards a circular economy [4]

The circular economy serves as a measure to counteract the traditional linear 'take-make-dispose' approach by reducing, reusing, and recycling resources throughout production, distribution, and consumption processes [7]. In the face of the challenges that SDG 12 addresses, the Urban Harvest Approach (UHA), a sustainable approach to urban living, emerges as a potential solution for achieving a circular economy. The UHA advocates transitioning from a linear to a circular metabolism, emphasizing the recycling and reusing of resources within the urban system [8]. This approach aligns with the principles of sustainability and resilience, aiming to create urban areas that not only accommodate the rapidly increasing population but also promote environmental conservation and enhance the quality of life for their citizens. In the context of sustainable development, the UHA offers a promising pathway for addressing the complex interplay between (economic) growth and environmental sustainability within urban spaces. As cities confront the challenges posed by rapid urbanization and resource depletion, integrating UHA principles into spatial planning strategies

becomes increasingly relevant since spatial planning serves as a key mechanism for sustainably shaping the built environment and enhancing societal well-being. The UHA not only aligns with contemporary theories of sustainable development but also resonates with societal aspirations for livable, resilient, and inclusive cities. By integrating UHA principles into urban planning, policymakers can better address the evolving needs of urban populations while preserving environmental sustainability.

European countries have already integrated circular economy principles into policies that promote closed-loop systems by reducing the input of resources [9,10]. However, in African countries, a degree of ambiguity exists in both the understanding and implementation of the circular economy, particularly in the domains of research and policy formulation [11]. Notably, limited research has been conducted on the development of the circular economy in Africa, with Uganda standing out as one of the few African countries where such research has been undertaken [12]. As a result, Uganda is among the limited African countries that have taken steps to incorporate the circular economy concept into their policies.

Despite these efforts, doubts arise regarding the applicability of the UHA to Uganda's national context due to various factors. The country faces unique socio-economic and environmental challenges, including rapid population growth and economic instability. These contextual nuances may influence the effectiveness of implementing UHA principles, which were initially developed in response to different challenges and urban structures. Furthermore, the political and institutional context in Uganda introduces uncertainties. Issues such as corruption and regulatory enforcement could impact the translation of the UHA principles into concrete policies.

1.1. Research Problem

Despite Uganda's proactive approach towards circular economy policies, there is insufficient existing research to determine whether the principles of the UHA are incorporated into current policies. Hence, this research aims to contribute to the understanding of the applicability of the UHA to Ugandan urban policies, considering the potential it may hold. This research will conduct a thematic policy analysis based on Ugandan policies and regulations to answer the following research question:

To what extent are the principles of the UHA incorporated into Ugandan policies and regulations?

The research question will be answered by addressing the following sub-questions:

1. *How can the principles of the UHA be defined?*
2. *What policies and regulations regarding sustainable development exist in Uganda?*
3. *What are the key themes related to sustainable development that can be identified in the selected policies and regulations?*
4. *To what extent do these themes correspond with the principles of the UHA?*

Chapter 2 of this research will explain the theoretical foundation of the UHA and identify its guiding principles, thereby answering the first sub-question. Subsequently, chapter 3 will describe the methodology of this research, explaining the structure of the thematic policy analysis. Following this, the results and the answers to the other sub-questions will be presented in Chapter 4 and will serve as the foundation for answering the research question in Chapter 5.

2. Theoretical framework

To create a clear understanding of this research, it is essential to delve into the main concepts that form the foundation of this study. A solid theoretical framework will be established by defining the main concepts, which will support the research. In addition, the guiding principles of the UHA, and thus the answer to the first sub-question, will be determined.

2.1. Sustainable Development and Sustainable Development Goal 12

In 2015, the General Assembly of the United Nations (UN) established 17 Sustainable Development Goals (SDG) through the adoption of Agenda 2030, signifying a collective commitment by all UN Member States to prioritize sustainability [13]. Sustainable development, an increasingly popular yet ambiguously defined concept, combines development with environmental and equity considerations. There is little agreement among authors on the core issues, with Northern discussions often focusing on sustainability and Southern perspectives emphasizing development [14]. Definitions typically involve economic growth and conditions necessary for sustainability, such as those by Pezzey [15] and Pearce et al. [16]. Notably, the World Commission on Environment and Development's report, *Our Common Future* [17], defines it as meeting present needs without compromising future generations' ability to meet their own needs. Despite criticisms, this definition remains influential.

The SDG that holds significant importance in the context of responsible resource consumption and production is SDG 12: "Ensure Sustainable Consumption and Production Patterns" [13]. This goal is rooted in the understanding that production and consumption lie at the core of the global economy, generating wealth and overall welfare [18]. On the other hand, SDG 12 addresses the link between unsustainable production practices and consumption and their impact on the environment. Target 12.2 focuses on the efficient use of natural resources, evaluating the material footprint per capita, which has increased since the year 2000, indicating challenges in achieving efficient resource consumption [19]. The African continent presents unique challenges that require a targeted approach to achieving SDG 12. Africa has encountered rapid population growth and expansion of cities, contributing to heightened demand for resources. Despite being rich in human and natural resources, the continent faces economic recessions, corruption, and leadership issues leading to insecurity [20]. Examining

the implementation of sustainability measures in Africa holds the potential to significantly contribute to the achievement of SDG 12 in the region.

2.2. The Circular Economy

The circular economy concept has gained widespread recognition in academia. Despite its increasing prominence, the discourse surrounding the circular economy suffers from a lack of organization and diverse interpretations due to extensive and varied research. In response to this challenge, efforts have been made to establish consensus on the topic. Research by Kirchherr et al. [21] and Prieto-Sandoval et al. [22] aimed to bring coherence to the different perspectives on the circular economy. In this research, the circular economy is defined as a measure to counteract the traditional linear 'take-make-dispose' approach by reducing, reusing, and recycling resources throughout production, distribution, and consumption processes [7]. The circular economy concept spans various scales, necessitating different methods for analyzing and describing the current situation and the changes that need to be made. In this, urban metabolism emerges as a valuable tool for the city scale [23].

2.3. Urban Metabolism

In alignment with the ambitions of SDG 12, urban metabolism serves as a tool for measuring the flow of resources within an urban system and can be used as the groundwork for sustainable urban planning [6]. Wolman [24] was the first person to study urban metabolism by using national data on the use of resources such as food, water, and fuel, as well as the production rates of waste, sewage, and air pollution to determine the material flows per capita for a hypothetical American city of one million inhabitants. Typically, the urban metabolism of cities can be seen as a linear flow, where the substantial resource consumption and production of waste surpass the limits of natural supply and recycling [25] (see Fig. 1, left side). Circular metabolism, on the other hand, makes use of recycling and reusing waste output to lower resource consumption [26] (see Fig. 1, right side).

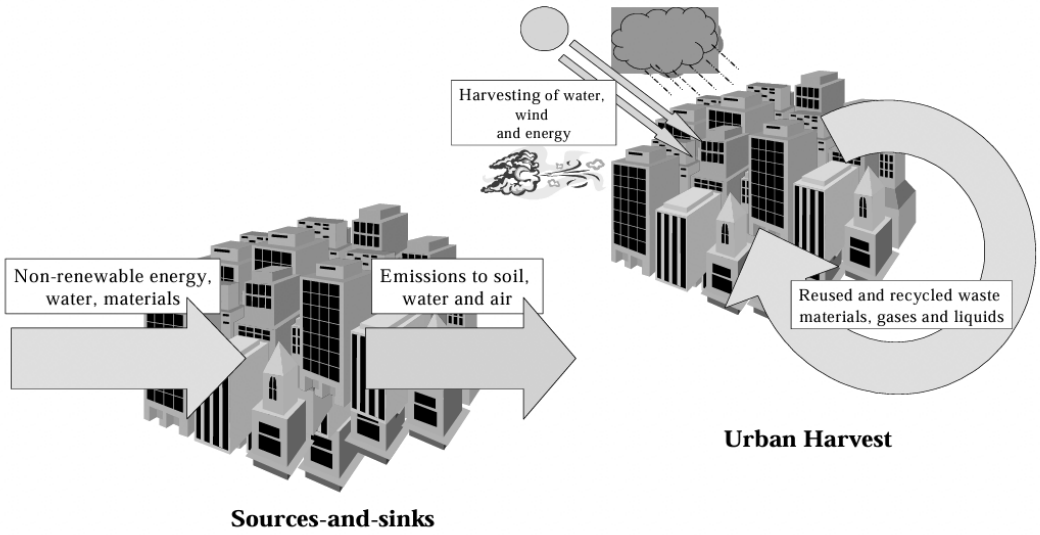

Figure 1 | Linear metabolism vs. circular metabolism [26]

2.4. The Urban Harvest Approach

Urban metabolism is fundamental to the UHA. Agudelo-Vera et al. [8] explain the UHA: "UHA works on the principle that urban systems can become - to a large extent - self-sufficient in resource supply and can reduce their waste production by improving local resource management at the smallest scale possible." Originally, the UHA was designed for water cycles, but it can be modified and applied to other resource cycles such as energy, nutrients, and organic matter as well [27]. The UHA strives to enhance resource management by suggesting a series of four sequential steps: (1) baseline assessment, (2) demand minimization, (3) output minimization, and (4) multisourcing [8].

The first step of the UHA is to create an inventory of demand. This baseline assessment quantifies the inputs, throughputs, and outputs of the urban system to understand the system's urban metabolism [8,27]. The second step and the first of the three principles of the UHA, demand minimization, aims to reduce the demand for resources in the urban system. To accomplish this, changes in human choices concerning consumption and disposal patterns are important, as is the implementation of technologies. Because human consumption and waste production mostly take place at the building unit, the UHA adopts a bottom-up approach from the smallest scale (the building level) to the scale of the overall case [25,27] (see Fig. 2).

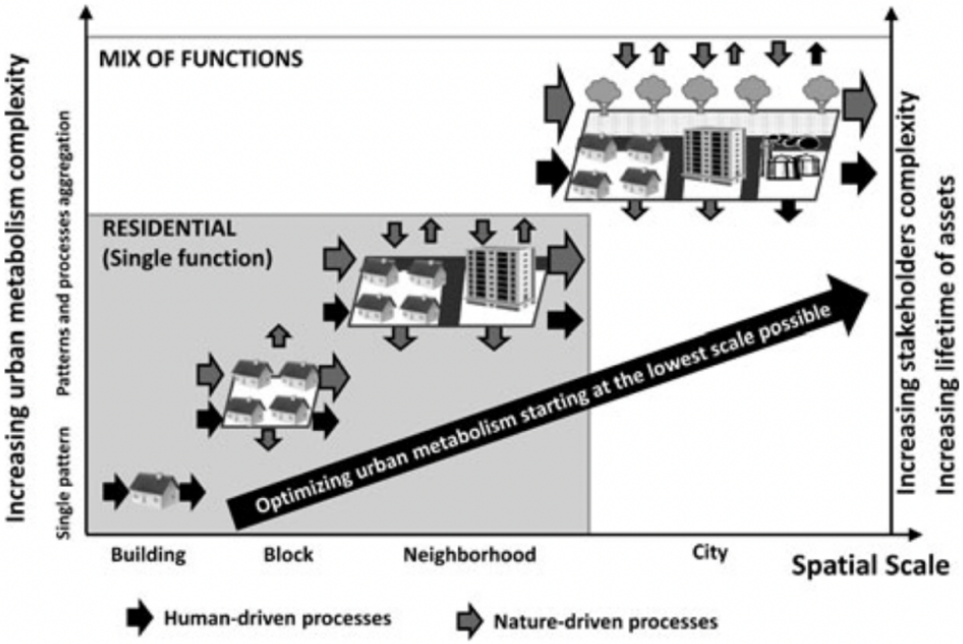

Figure 2 | Bottom-up approach proposed by the UHA to enhance urban metabolism [25]

Output minimization, the third step and second principle of the UHA, can be achieved by three different strategies as proposed by Leusbrock et al. [27] (see Fig. 3):

- *Cascading of resources (Fig. 3a):*
  Cascading harvests the residual quality of a resource, using it for activities that require resources of lower quality. This cascading flow of energy ensures that a given input can facilitate a greater number of activities, thereby enhancing the efficiency of resource use [28].
- *Recycling of resources (Fig. 3a):*
  Recycling is the process of treating resources to enable further reuse. As stated by Agudelo-Vera et al. [8], the recycling of resources requires additional energy. Consequently, the feasibility of recycling should be carefully considered, taking into account the selection of suitable recycling technologies for the specific case.
- *Recovery of resources (Fig. 3b):*
  Recovery refers to the extraction of valuable products from waste streams. An example of this process is the retrieval of methane-containing biogas from wastewater which can be utilized for, for instance, heat or electricity generation [29].

The final step and the third principle of the UHA is the multisourcing. Multisourcing involves creating a resource supply that is sourced from local and renewable resource potential. These locally created resources can be used to fulfill any remaining demand after steps 2 and 3 of the UHA, while simultaneously reducing the reliance on the hinterlands [8].

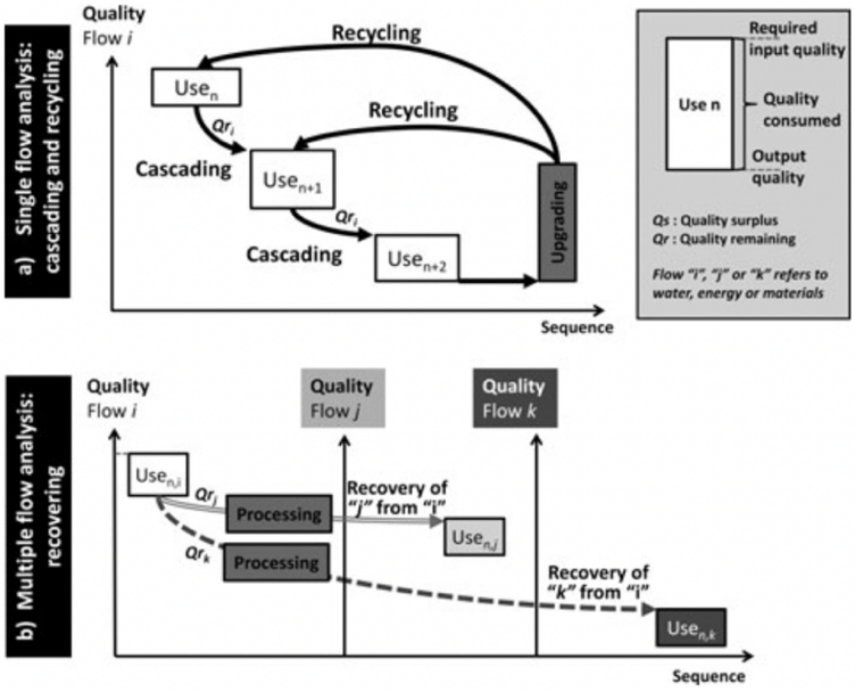

Figure 3 | Three strategies for minimizing outputs: (a) cascading and recycling; (b) recovering [8]

2.5. Conceptual model

Positioned as a guiding paradigm, SDG 12 directs urban areas towards resiliency and sustainability (see Fig. 4). The connection from SDG 12 to circular economy signifies a recognition that the realization of sustainable development requires a shift from conventional linear resource utilization to a more circular approach. The urban metabolism concept distinguishes between two resource flow pathways: linear and circular metabolism. Circular metabolism, closely connected to the UHA, introduces a circular method to resource utilization, realized through the principles of demand minimization, output minimization, and multisourcing.

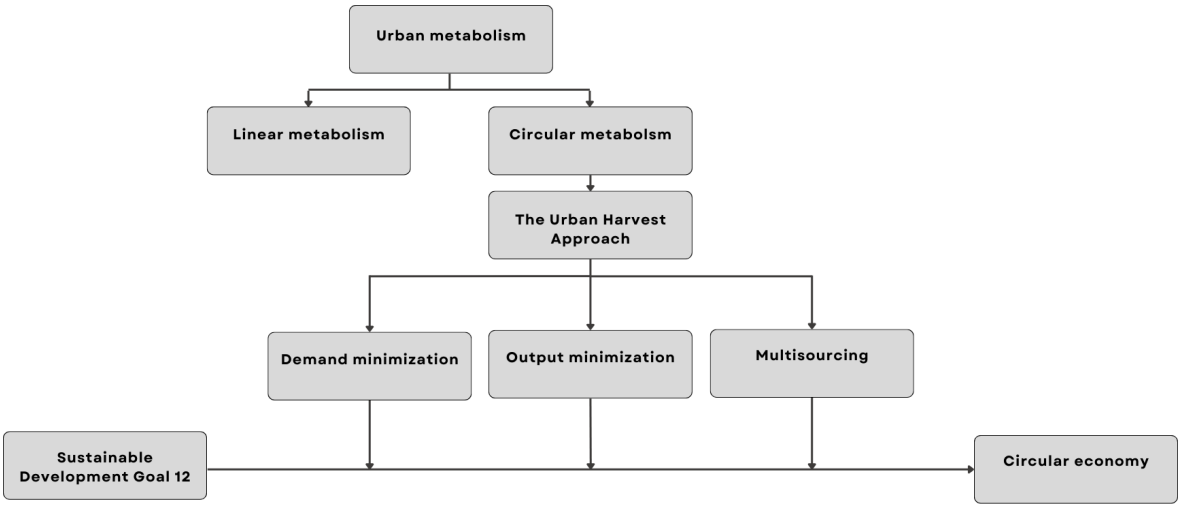

Figure 4 | Conceptual model (Author's own)

2.6. Expectations

This research revolves around the expectation that the principles of the UHA in Ugandan circular economy policies may encounter challenges shaped by the country's socio-economic, political, and institutional factors. The expected outcome of this research suggests that the contextual nuances may influence the feasibility and effectiveness of incorporating the principles of UHA into sustainable development policies, necessitating customized strategies for sustainable urban development in Uganda.

3. Methodology

This chapter outlines the methodology that will be used to answer the research question and sub-questions. The methodology primarily involves the analysis of selected policy documents to identify the existing policies and regulations and their contents regarding the UHA in Uganda. This will be done by conducting a thematic policy analysis based on 8 policy documents (see Table 1). The selection of these documents for analysis is well-founded, as they collectively represent a comprehensive spectrum of Uganda's policy landscape, spanning from the foundational Vision 2040 [30] to more recent strategic frameworks such as the Uganda Green Growth Development Strategy (UGGDS) [31] and the Third National Development Plan (NDP III) [32].

Table 1 | Policies, regulations, and laws used for thematic policy analysis (Author's own)

Policy document	Year
Vision 2040	2007
First National Development Plan (NDP I) [33]	2010
Second National Development Plan (NDP II)	2015
National Climate Change Policy	2015
The Uganda Green Growth Development Strategy (UGGDS)	2017
Third National Development Plan (NDP III)	2020
The National Environment (Waste Management) Regulations	2020
Uganda Energy Transition Plan	2023

Uganda's Vision 2040 serves as a foundation, articulating a commitment to a sustainable and green economy as early as 2007. Subsequent National Development Plans, especially the Second National Development Plan (NDP II) [34] incorporating the SDGs, demonstrate a progressive approach towards green growth and climate action. The adoption of the National Climate Change Policy [35] in 2015 and the subsequent development of the UGGDS in 2017 show dedicated efforts to align national strategies with climate-resilient and environmentally sustainable pathways. The inclusion of sector-specific strategies like the National Environment (Waste Management) Regulations [36] and the Uganda Energy Transition Plan [37] reflects a

nuanced understanding of diverse facets of sustainable development. Additionally, the NDP III's focus on circular economy principles demonstrates an evolving policy landscape responsive to global sustainability agendas. The interconnectedness of these documents reveals a strategic and informed approach, indicating a collective effort to integrate green and circular economy principles across different sectors, providing a solid foundation for the analysis.

The thematic policy analysis, inspired by Braun and Clarke's [38] approach, aims to identify key themes in the selected policy documents, answering sub-question 3 (see Fig. 5). This approach consists of 5 steps:

1. *Familiarization with the data:*
   Reading the data and taking notes to create a coding scheme. Familiarization with the data holds significance as it directly contributes to answering sub-question 2 (see Fig. 5).
2. *Generating initial coding:*
   Coding of ideas and concepts relevant to the research question. A manual coding matrix will be used to generate the initial codes, each row corresponding to a policy document, and each column representing a code or category related to the research question. Checkmarks are placed in the corresponding cells under code columns, signifying the relevance of each code to the document. As more documents are reviewed, codes will be added, expanded, and refined based on emerging themes and patterns.
3. *Searching for themes:*
   Identifying overarching themes that arise from the codes determined in step 2.
4. *Reviewing themes:*
   Reviewing the themes to ensure coherence with the coded extracts (step 1) and dataset (step 2).
5. *Defining and naming themes:*
   Refining the themes to create clear definitions and names for each theme, reflecting the contents of the documents. A thematic map is generated to visually represent the analysis.

The themes that derive from analysis will play an important role in answering sub-question 4. These themes are examined to determine if they correspond with the principles of the UHA (demand minimization; output minimization; multisourcing) that were identified in the theoretical framework (see Fig. 5). This comparative analysis aims to uncover alignment or divergence between the UHA and Ugandan policies and regulations, thus answering the research question.

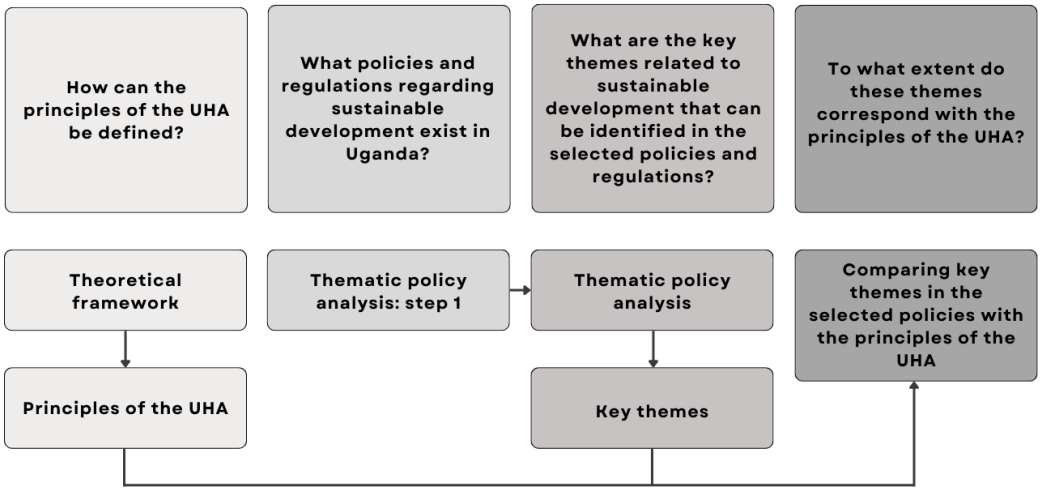

Figure 5 | Data analysis scheme (Author's own)

3.1. Ethical considerations

This research involves the examination of publicly available policy documents, minimizing the risk of privacy concerns or unauthorized use of sensitive information. However, it is crucial to uphold ethical standards in the interpretation and reporting of findings, avoiding misinterpretation or selective reporting that may lead to biased conclusions. Transparency in the selection of policy documents and the rationale behind their inclusion is essential to maintaining the research's credibility and impartiality. Furthermore, considering the local impact of the UHA principles is crucial, as different communities within Uganda may experience varied effects. Ethical research practices are important in addressing potential disparities in the application and outcomes of these policies, ensuring that the study does not inadvertently contribute to existing inequalities but rather promotes equitable sustainable practices.

4. Results

4.1 Existing policies and regulations regarding the UHA

The strategic frameworks and policies in Uganda's development landscape all aim for sustainable development, aligning with global (sustainability) goals while considering Uganda's specific challenges and opportunities. This unified approach focuses on improving socio-economic conditions while also protecting the environment. In addressing these goals, this section will answer the second sub-question: *What policies and regulations regarding sustainable development exist in Uganda?*

4.1.1. Vision 2040

The Vision 2040 outlines Uganda's long-term development goals. It aims to transform the nation from a predominantly low-income country into a competitive upper-middle-income country. Vision 2040 addresses strategic bottlenecks hindering socio-economic development, including a weak private sector, underdeveloped human resources, inadequate infrastructure, and challenges in democracy.

Sustainable development is a core principle guiding Uganda's transformation. The Vision emphasizes promoting alternative energy sources, ensuring access to safe water and modern sanitation facilities, and planned urbanization for efficient service delivery.

4.1.2. The National Development Plans I, II and II

Similarly, the National Development Plans (NDP I, II, III) outline strategies integrating economic growth with poverty reduction, sustainable resource management, and environmental conservation. These plans serve as a guide to Uganda's socio-economic development trajectory over specific periods, with each plan building upon the achievements and challenges of its predecessor while aligning with Uganda's broader development aspirations, including the Vision 2040 and international commitments such as the SDGs.

The NDPs provide a detailed strategy for stimulating sustainable development and economic growth within the country. Firstly, all three NDPs emphasize the importance of sustainable

resource management. For example, the plans advocate for the implementation of sustainable agriculture practices, such as crop rotation, agroforestry, and water-efficient irrigation systems to optimize land use and conserve soil fertility. They also propose policies to regulate land use and prevent deforestation, ensuring the preservation of natural habitats and biodiversity.

Secondly, the NDPs prioritize local resource utilization and community empowerment by promoting initiatives such as community-based natural resource management programs. These programs empower local communities to take ownership of natural resources, implement sustainable land management practices, and participate in decision-making processes related to resource allocation and utilization. Additionally, the plans advocate for the promotion of small-scale industries and cooperatives, which enable communities to harness local resources for economic development while preserving traditional livelihoods.

Furthermore, the NDPs emphasize the importance of innovation, technology, and knowledge-sharing in driving sustainable development. They propose measures to promote the adoption of sustainable technologies and practices. For instance, the plans encourage the use of renewable energy technologies, such as solar panels and biogas digesters, to enhance self-sufficiency.

4.1.3. The National Climate Change Policy

The NCCP is fundamental to Uganda's approach to addressing climate change while promoting sustainable development. In response to the global challenge of climate change, the policy sets out to mitigate its impacts and foster resilience through sustainable practices. It recognizes the intertwined nature of climate change and sustainable development, aiming to integrate climate considerations into sectoral policies and strategies.

In the energy sector, the policy emphasizes the transition to cleaner, renewable energy sources. This includes promoting hydropower and solar energy development. Furthermore, water resources management is prioritized, recognizing climate change's impact on water availability and quality. Strategies include water harvesting and efficient utilization to enhance resilience to climate change impacts. The policy emphasizes sustainable natural resource management to ensure resilient agricultural systems and reduced emissions. This involves promoting

conservation agriculture, ecologically compatible cropping systems, and sustainable rangeland management. Waste management is addressed through sustainable practices such as composting, recycling, and waste-to-energy initiatives to minimize environmental impact and reduce greenhouse gas emissions. The policy's cross-cutting approach considers biodiversity conservation and disaster risk management while working towards circularity.

4.1.4. The Uganda Green Growth Development Strategy

The UGGDS aims to foster an inclusive, low-emissions economic growth process while emphasizing the efficient use of natural, human, and physical capital by prioritizing green growth principles. The goal is to enhance income, promote climate resilience, and manage resources sustainably, aligning with Uganda's socio-economic transformation goals.

In the energy sector, the UGGDS places significant emphasis on transitioning towards cleaner and renewable energy sources to reduce reliance on fossil fuels and mitigate greenhouse gas emissions. Initiatives include promoting hydropower, solar, wind, and other renewable energy sources to support economic growth while improving energy access and efficiency. Sustainable water management recognizes the importance of efficient water use and conservation. The UGGDS advocates for the implementation of water harvesting techniques, promoting water-efficient technologies, and enhancing water infrastructure to ensure water security for various sectors. Sustainable waste management is another key focus area of the UGGDS, aiming to minimize waste generation and promote recycling and resource recovery. The strategy emphasizes the importance of proper waste disposal practices, waste-to-energy initiatives, and recycling programs to reduce environmental pollution and greenhouse gas emissions and promote a circular economy.

4.1.5. The National Environment (Waste Management) Regulations

The National Environment (Waste Management) Regulations establish a waste management hierarchy, prioritizing waste prevention, minimization, reuse, recycling, recovery, and safe disposal. Furthermore, the regulations introduce Extended Producer Responsibility (EPR) requirements, holding producers accountable for the entire lifecycle of their products. This approach promotes sustainable production and consumption patterns by reducing waste generation and promoting circularity. By adopting the best available technologies and

environmental practices, stakeholders can enhance resource efficiency and minimize environmental impact.

Waste minimization and recycling are central to the regulations, with waste generators mandated to classify, segregate, and package waste appropriately to facilitate recycling and reuse and encourage the recovery of valuable resources. Stakeholders are encouraged to establish recycling facilities and support recycling initiatives to promote a circular economy and reduce waste generation. Waste-to-energy, including incineration and cogeneration, is described as a strategy for managing non-recyclable waste and generating energy. The regulations ensure that the facilities comply with environmental standards to mitigate potential risks to the environment and public health. While waste-to-energy contributes to reducing waste volume and providing energy resources, adherence to regulatory standards and environmental safeguards is crucial to minimizing negative impacts.

4.1.6. The Uganda Energy Transition Plan

The Energy Transition Plan guides Uganda towards a sustainable and modern energy system. This plan aims to support Uganda's economic transformation by enhancing energy access, promoting renewable energy sources, improving energy efficiency, and reducing greenhouse gas emissions.

The plan prioritizes the transition to cleaner energy sources such as solar, wind, hydro, geothermal, and nuclear power, aiming to diversify the energy mix, reduce reliance on fossil fuels, and mitigate environmental impacts, aligning with sustainability objectives. Efforts are directed towards improving energy efficiency across sectors, including buildings, agriculture, and transport, with initiatives such as mandatory energy audits for buildings and incentives for adopting energy-efficient practices aiming to minimize energy waste and promote sustainability. Uganda commits to reducing emissions and achieving net-zero emissions in the energy sector by 2065, emphasizing the importance of sustainable energy practices in mitigating climate change impacts and fostering a cleaner energy future. Exploiting Uganda's abundant renewable energy resources and minerals sustainably is prioritized, with encouragement for the adoption of energy-efficient technologies and sustainable practices in various sectors aiming to minimize resource consumption and promote sustainability.

4.2. Thematic analysis of sustainable development policies in Uganda

After completing steps 2 through 5 of the thematic analysis, four overarching themes have emerged, each characterized by three sub-themes. Figure 6 summarizes the key themes identified along with their corresponding sub-themes. The results of this thematic analysis have answered the third sub-question: *What are the key themes related to sustainable development that can be identified in the selected policies and regulations?*

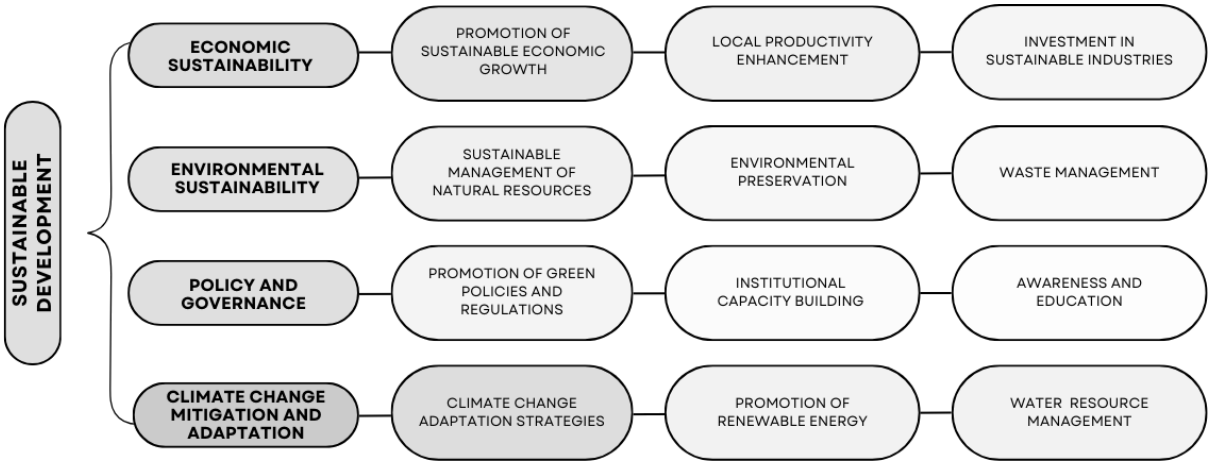

Figure 6 | Key themes and sub-themes of sustainable development policies in Uganda (Author's own)

The themes and sub-themes identified from the thematic analysis will be discussed in relation to the principles of the UHA, therefore answering the fourth sub-question: *To what extent do these themes correspond with the principles of the UHA?*

4.2.1. Economic sustainability

At the heart of Uganda's economic sustainability agenda lies a commitment to *promoting sustainable economic growth* as a catalyst for poverty reduction, job creation, and overall socio-economic development. Recognizing the centrality of the agricultural sector in Uganda's economy, policymakers have placed a strong emphasis on enhancing agricultural productivity, improving market access for smallholder farmers, and fostering value addition along agricultural value chains [31-34]. By prioritizing *local productivity enhancement*, Uganda seeks to unlock the full potential of its agricultural sector, boost rural incomes, and stimulate

economic diversification—a critical imperative in a country where agriculture remains the backbone of the economy and the primary source of livelihood for the majority of the population [30,32-34]

Moreover, Uganda's economic sustainability strategy is underpinned by *investment in sustainable industries*, through leveraging indigenous resources and encouraging homegrown solutions to development challenges. By exploiting its abundant natural resources, including fertile agricultural land, renewable energy potential, and mineral deposits, Uganda aims to stimulate domestic resource mobilization, enhance economic self-reliance, and reduce dependency on external aid [30-35]. Additionally, Uganda's focus on promoting sustainable economic growth aligns with its vision of achieving middle-income status by 2040, as articulated in Uganda Vision 2040, which underscores the importance of sustainable economic development as a basis for national development aspirations.

In evaluating Uganda's economic sustainability initiatives, several key principles of the UHA resonate with the country's policy landscape. Uganda's focus on local productivity enhancement aligns closely with the principle of demand minimization advocated by the UHA. By prioritizing initiatives that enhance agricultural productivity, improve market access, and promote value addition, Uganda aims to meet local demand for food and agricultural products within its urban centers, thereby reducing reliance on imports and minimizing external dependencies. This approach resonates with the UHA's emphasis on fostering self-sufficiency and reducing the need for long-distance transportation of goods, thus minimizing demand pressure on external resources.

Uganda's emphasis on leveraging indigenous resources and fostering homegrown solutions to development challenges reflects a form of multisourcing. However, there is room for Uganda to explore opportunities for multisourcing at the local level, such as promoting community-led initiatives for resource management, encouraging decentralized energy generation projects, and facilitating knowledge exchange networks among communities. These efforts would not only align with the principle of multisourcing advocated by the UHA but also empower local communities to actively participate in sustainable development initiatives.

4.2.2. Environmental sustainability

Situated within the Great Lakes region of East Africa, Uganda boasts a remarkable diversity of ecosystems, including rainforests, wetlands, fertile agricultural lands, and abundant water resources. These natural assets not only support biodiversity and provide critical ecosystem services but also serve as the backbone of Uganda's economy, sustaining livelihoods for generations. However, alongside the countless benefits derived from its natural endowment, Uganda faces a multitude of environmental challenges that threaten the long-term sustainability of its ecosystems and the well-being of its people [30-32,34,35].

Deforestation driven by agricultural expansion, charcoal production, and logging activities has led to the loss of vital forest cover, resulting in soil erosion, habitat degradation, and heightened vulnerability to climate change impacts [32-35]. Similarly, unsustainable land use practices, including over-harvesting, unregulated mining activities, and wetland invasion, have further exacerbated environmental degradation, undermining ecosystem integrity and diminishing the resilience of local communities [32,34,35,37] Moreover, water pollution stemming from industrial effluents, agricultural runoff, and inadequate sanitation infrastructure has degraded water quality in rivers, lakes, and groundwater sources, posing serious health risks and threatening aquatic ecosystems [31-34].

In response to these environmental challenges, the analyzed policy documents aim at promoting environmental sustainability, *managing natural resources sustainably*, and *supporting environmental preservation*. Central to this is the promotion of sustainable land management practices, including agroforestry, soil conservation, and watershed management initiatives, which seek to enhance soil fertility, prevent erosion, and protect water resources [31,32,34,35]. Conservation efforts are complemented by community-based initiatives that empower local communities to actively participate in natural resource management and biodiversity conservation, fostering a sense of stewardship over shared environmental assets [31-35,37].

In evaluating the extent to which these environmental sustainability themes correspond with the principles of the UHA, several key intersections emerge. Firstly, Uganda's emphasis on sustainable land management practices, conservation initiatives, and waste management strategies aligns closely with the UHA's principle of output minimization. By prioritizing

initiatives that aim to reduce waste generation, promote recycling, and recover valuable resources, Uganda seeks to optimize resource utilization, minimize environmental impact, and enhance ecosystem resilience [36]. However, while Uganda has made strides in waste management regulation and enforcement, challenges remain in ensuring the widespread adoption and implementation of sustainable waste management practices across all sectors.

Secondly, Uganda's promotion of sustainable agriculture practices, such as agroforestry and soil conservation, resonates with the UHA's principle of demand minimization. By enhancing soil fertility, preventing erosion, and promoting sustainable land use practices, Uganda endeavors to minimize the demand for external inputs while maximizing agricultural productivity and resilience. However, despite efforts to promote sustainable agriculture, challenges persist in addressing underlying drivers of deforestation, such as agricultural expansion and charcoal production, which continue to exert pressure on forest ecosystems and biodiversity.

Furthermore, Uganda's conservation initiatives, including the establishment of protected areas and wildlife reserves, reflect a commitment to preserving biodiversity and critical habitats—an objective that aligns closely with the UHA's principle of multisourcing. By safeguarding natural ecosystems and promoting community-based conservation initiatives, Uganda seeks to diversify its resource base, enhance ecological resilience, and secure ecosystem services essential for human well-being. However, sustained conservation efforts are needed to address emerging threats, such as habitat fragmentation and climate change, which pose significant challenges to biodiversity conservation and ecosystem integrity.

Expanding on *waste management*, Uganda’s embrace of waste-to-energy solutions, incineration, and cogeneration exemplifies cascading of resources, aligning closely with the UHA’s principle of output minimization. By employing these strategies, Uganda aims to manage non-recyclable waste effectively while generating energy resources. However, ensuring adherence to environmental standards and mitigating potential negative impacts remain paramount in the implementation of these waste management practices.

4.2.3. Policy and governance

Uganda's policy and governance landscape plays an important role in shaping the trajectory of sustainable development within the country, translating overarching aspirations into actionable policies and practices. Anchored in principles of good governance, transparency, and accountability, Uganda's governance framework encompasses a diverse array of initiatives aimed at promoting green policies, building institutional capacity, and fostering awareness and education. These efforts reflect Uganda's commitment to creating an enabling environment conducive to sustainable development outcomes, where effective governance structures and robust policy frameworks serve as an impulse for positive change.

The *promotion of green policies* represents the foundation of Uganda's governance agenda, reflecting a recognition of the imperative to integrate environmental considerations into policy formulation and implementation [30-35]. Through the enactment of legislation, development of regulatory frameworks, and incentive mechanisms, Uganda seeks to incentivize sustainable practices, mitigate environmental degradation, and promote resource efficiency across sectors [31-35,37].

Institutional capacity building represents another key pillar of Uganda's governance strategy, aimed at strengthening the capacity of government institutions, civil society organizations, and other stakeholders to effectively engage in sustainable development processes [30,32-34,37]. By fostering a culture of learning, innovation, and collaboration, Uganda harnesses the collective wisdom and ability to achieve green growth principles. Furthermore, Uganda's emphasis on *awareness and education initiatives* emphasizes its commitment to fostering a culture of environmental stewardship, civic engagement, and social responsibility, laying the groundwork for inclusive and sustainable development [31-37]. By raising awareness about the importance of sustainable resource management, environmental conservation, and climate action, Uganda aims to drive collective action towards shared sustainability goals.

When examining how well this theme aligns with the principles of the UHA, several points of connection were uncovered. Uganda's emphasis on promoting green policies aligns with the UHA's focus on minimizing environmental impact and optimizing resource utilization through sustainable practices and regulations. Similarly, efforts to build institutional capacity and foster awareness and education resonate with the UHA's emphasis on stakeholder engagement,

capacity building, and knowledge sharing as enablers of sustainable development by taking a bottom-up approach. However, challenges such as limited institutional capacity, inadequate enforcement mechanisms, inadequate monitoring, and competing development priorities pose significant barriers to fully operationalizing UHA principles within Uganda's governance framework. Addressing these challenges will require sustained efforts to strengthen governance structures, enhance stakeholder engagement, and foster a culture of accountability and transparency, thereby creating an enabling environment for the implementation of UHA-inspired policies and practices.

4.2.4. Climate change mitigation and adaptation

Uganda's climate change mitigation and adaptation efforts are integral components of its broader strategy to foster sustainable development and enhance resilience to environmental challenges intersecting with the principles of the UHA.

The *promotion of renewable energy* represents a key pillar of Uganda's climate change mitigation strategy, aligning with the principles of the UHA by emphasizing the importance of multisourcing and minimizing reliance on non-renewable energy sources. By utilizing potential renewable energy resources, Uganda seeks to reduce greenhouse gas emissions, enhance energy security, and promote sustainable development [31-35,37].

Water resource management is another critical aspect of Uganda's climate change adaptation strategy [31-34]. By integrating climate considerations into water resource planning, allocation, and management processes, Uganda seeks to enhance water security, reduce vulnerability to climate-related hazards such as droughts and floods, and safeguard ecosystem services that are essential for human well-being [32,35].

Moreover, Uganda's focus on *climate change adaptation strategies* emphasizes its commitment to building resilience and adaptive capacity among vulnerable communities, aligning with the principles of the UHA by emphasizing the importance of demand minimization and output minimization through efficient resource utilization and waste reduction.

In evaluating the extent to which these climate change mitigation and adaptation themes correspond with the principles of the UHA, several key intersections emerge. Uganda's emphasis on promoting renewable energy aligns with the UHA's focus on multisourcing and minimizing environmental impact through sustainable energy practices. Similarly, efforts to enhance water resource management and promote climate-resilient infrastructure resonate with the UHA's principles of demand minimization and output minimization by optimizing resource utilization and minimizing waste. However, challenges such as limited financial resources, institutional capacity constraints, and competing development priorities pose significant barriers to fully operationalizing UHA principles within Uganda's climate change policy framework. Addressing these challenges will require sustained efforts to strengthen policy coherence, enhance stakeholder engagement, and foster innovative solutions that integrate climate considerations into broader development planning processes, thereby advancing Uganda's sustainable development goals in the face of climate change uncertainties.

Table 2 | Thematic policy analysis results by selected policy or regulation (Author's own)

	Vision 2040	NDP I, II, III	National Climate Change	UGGDS	National Environment (Waste Management) Regulations	Energy Transition Plan
Economic sustainability						
Promotion of Sustainable Economic Growth	✓	✓	✗	✓	✗	✗
Local Productivity Enhancement	✓	✓	✗	✗	✗	✗
Investment in Sustainable Industries	✓	✓	✓	✓	✗	✗
Environmental Sustainability						
Sustainable Management of Natural Resources	✓	✓	✓	✓	✗	✓
Environmental Preservation	✓	✓	✓	✓	✓	✓
Waste Management	✓	✓	✗	✓	✓	✓
Policy and Governance						
Promotion of Green Policies and Regulations	✓	✓	✓	✓	✓	✓
Institutional Capacity Building	✓	✓	✗	✗	✗	✓
Awareness and Education	✗	✓	✓	✓	✓	✓
Climate Change Mitigation and Adaptation						
Climate Change Adaptation Strategies	✓	✓	✓	✓	✗	✓
Promotion of Renewable Energy	✗	✓	✓	✓	✗	✓
Water Resource Management		✓	✓	✓	✗	✗

5. Conclusion

This research explored the extent to which the principles of the UHA are integrated into Ugandan policies and regulations within the context of sustainable development and circular economy initiatives.

Through a thematic policy analysis, this study examined existing Ugandan policies and regulations across four themes: economic sustainability, environmental sustainability, policy and governance, and climate change mitigation and adaptation. The analysis revealed that while Uganda demonstrates a proactive approach towards sustainable development, with policies addressing various aspects of resource management and environmental conservation, there are limitations in fully operationalizing the principles of the UHA within the existing policy landscape.

Although there are notable parallels between Uganda's policy framework and the principles of the UHA, several challenges and limitations exist. The principles of the UHA are integrated into Ugandan policies in a way that aligns with the country's needs and challenges. While the UHA may have been initially developed for developed-world contexts, it emphasizes the importance of contextualizing sustainability strategies to address the complexities and opportunities present in each setting. Despite facing challenges such as limited institutional capacity as also mentioned by Geme et al. [39], inadequate enforcement mechanisms, and competing development priorities as also mentioned by Mayanja and Nkata [40], which hinder the effective implementation of UHA principles, its implementation in Uganda demonstrates a commitment to advancing sustainable urban futures.

Further, while data availability was not a significant challenge in accessing reliable documents for this study, limitations were encountered in obtaining an overview of all the policies that could have been applicable to the research. This difficulty suggests that there may have been suitable policies that were overlooked, highlighting the possibility of missed opportunities where certain policies could have been highly relevant but were not included.

In reflection, while this research has provided valuable insights into the alignment between Ugandan policies and the principles of the UHA, it also acknowledges the complexity of the socio-economic and political context within which these policies operate. Moving forward,

continued efforts to bridge the gap between policy formulation and implementation will be essential to advance sustainable development goals and promote resilient and inclusive urban ecosystems. Further research on the actual implementation of the UHA could be conducted by conducting comparative analyses between sustainable development policies and available monitoring documents or direct observations. Through this approach, areas of alignment between policy and outcome, as well as potential gaps or discrepancies that may hinder effective implementation can be identified. By shedding light on the practical challenges and opportunities associated with implementing the UHA principles in the real-world context, the research can inform policy adjustments and other interventions aimed at advancing the country's sustainable development goals. According to Mayanja and Nkata [40], however, there are still gains to be made in establishing monitoring and evaluation systems.

6. References

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