



National Innovation Systems and the Sustainable Development Goals in Sub-Saharan Africa: A Systematic Review of Pathways, Gaps, and Policy Interfaces

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ABSTRACT

In Sub-Saharan Africa, national innovation systems are increasingly cited as instruments for achieving the Sustainable Development Goals, but evidence on their effectiveness and coherence remains fragmented. Analysing 161 studies published between 2020 and 2025, this review finds that while national innovation systems are widely promoted in development policy, its integration into SDG strategies remains limited and inconsistent. Most contributions are focused on agriculture, energy, health, and education but lack system-wide coordination, monitoring, and long-term support. Only a few countries have aligned innovation policies with SDG implementation plans. Institutional fragmentation, weak evaluation frameworks, and regional research imbalances continue to hinder progress. The review recommends adopting modular innovation sub-systems, improving policy–SDG alignment, investing in monitoring systems, and expanding support for cross-sector and regional research collaboration. Strengthening the NIS–SDG interface is essential for building inclusive, responsive, and sustainable development pathways in the region.

Keywords: National Innovation Systems, Sustainable Development Goals, Sub-Saharan Africa, Innovation Policy, Institutional Capacity

JEL Codes : O31, O32, O38, Q01, I38, H41

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1. INTRODUCTION

Innovation is increasingly recognised as a foundational engine of sustainable development, not only for its role in driving technological progress but for its capacity to reshape institutions, stimulate inclusive growth, and enable countries to respond to complex socio-economic challenges (Adebayo, 2025). In recent decades, the concept of the National Innovation System (NIS) has gained traction as a strategic framework for understanding how nations mobilise knowledge, institutions, and policies to foster innovation (Antonenko, 2020; Atkinson, 2014; Bokachev, 2019; Burkina, 2024; Ngoc Ca & Thanh Tung, 2023). Originally conceptualised by scholars such as Freeman (1987), Lundvall (1992), and Nelson (1993), the NIS approach emphasises that innovation does not occur in isolation but is embedded within a broader constellation of actors, including government bodies, research institutions, private firms, and civil society. These actors interact through formal structures and informal networks, shaped by policy regimes, institutional quality, and cultural context (Tomareva-Patlahkova et al., 2022; Weerasinghe et al., 2024).

The NIS framework has been adopted widely as a tool for guiding national and regional innovation strategies, particularly in high-income and middle-income countries (Weerasinghe et al., 2024). It provides a systems-based perspective that moves beyond linear models of technological diffusion and instead focuses on feedback loops, institutional linkages, and cumulative learning (Yim & Nath, 2005; Zemlyakov, 2021; Пятыхкин, 2020). In doing so, it underscores the importance of coordination, capacity-building, and long-term investment in innovation infrastructure. For developing countries, especially in Sub-Saharan Africa, the appeal of the NIS model lies in its potential to align fragmented innovation efforts with coherent national development goals (Butko, 2019).

Parallel to the evolution of NIS thinking, the Sustainable Development Goals (SDGs) have emerged as the most comprehensive global framework for development planning. Adopted by the United Nations in 2015, the SDGs comprise 17 interlinked goals and 169 targets that span economic growth, environmental sustainability, health, education, gender equality, governance, and more (Ndicu et al., 2023; Nenni et al., 2024). Unlike earlier development frameworks, the SDGs explicitly recognise the multidimensional and systemic nature of development challenges, placing a strong emphasis on policy integration and institutional coordination (Chirambo, 2021; Halder et al., 2023; Lukman et al., 2023; Roger et al., 2022).

The convergence between NIS frameworks and the SDGs is conceptually and practically significant. Both are concerned with systems-level change, long-term transformation, and cross-sectoral collaboration. Innovation is not merely Goal 9 (Industry, Innovation, and Infrastructure); it is a cross-cutting enabler that underpins progress in nearly every domain from clean energy (Goal 7) to climate action (Goal 13), from education (Goal 4) to health systems (Goal 3) (Akhtar-Schuster et al., 2024; Chirambo, 2021). As such, the question is not whether innovation matters for development, but how innovation systems can be structured and governed to serve sustainable development outcomes.

In the context of Sub-Saharan Africa, this question becomes especially urgent. The region faces persistent structural constraints: underfunded research institutions, weak innovation ecosystems, limited private sector R&D, and fragmented policy environments (Ofori et al., 2022; Nenni et al., 2024). At the same time, African countries are under growing pressure to

deliver on the SDGs while navigating climate risks, demographic shifts, and rapid urbanisation (Akhtar-Schuster et al., 2024). In this setting, the effectiveness of innovation systems is not just a matter of competitiveness; it is central to resilience, equity, and sustainability (Halдар et al., 2023; Jjagwe et al., 2024). However, there is limited consolidated evidence on how well NIS frameworks in Sub-Saharan Africa are aligned with the imperatives of the SDGs.

This review responds to that gap. By systematically examining the literature at the intersection of NIS and SDG discourse, it aims to clarify the theoretical pathways, institutional mechanisms, and policy implications of aligning innovation systems with sustainable development in the African context.

Problem Statement

In recent years, innovation has come to occupy a central role in development discourse across Sub-Saharan Africa (Afful Jr, 2010; Atkinson, 2014; Bokachev, 2019). National governments, regional blocs, and international development agencies increasingly frame innovation as a catalyst for economic diversification, institutional reform, and inclusive growth (Yim & Nath, 2005). The adoption of NIS frameworks in strategic planning documents reflects this shift, as countries seek to build local capacities in science, technology, and knowledge production (Noeh et al., 2022). However, the extent to which these emerging NIS frameworks are substantively contributing to the achievement of the SDGs remains unclear.

A growing number of academic and policy-oriented studies explore aspects of innovation and sustainability in Africa (Ngoc Ca & Thanh Tung, 2023; Weerasinghe et al., 2024). Yet, the literature is marked by fragmentation across disciplines, sectors, and analytical perspectives. Some studies focus on science and technology policy (Antonenko, 2020; Yim & Nath, 2005; Пятыйжкин, 2020), others on entrepreneurship ecosystems (Mosurović Ružičić et al., 2021; National Aviation University & Komandrovskaya, 2024; Bulgaria & Mihaylov, 2024), others still on sector-specific innovations in agriculture, health, or energy (‘Introduction to the Innovation and Development of Agricultural Systems—Cases from Brazil, Russia, India, China, and South Africa (BRICS)’, 2024; ‘The National Innovation System as Applied to Agriculture’, 2023; Ran & Qijia, 2025; Sarkodie et al., 2023; Vasyliiev, 2021; Yoo et al., 2025; Zhang et al., 2024). While many invoke the language of systems and sustainability, few adopt an integrated view of how institutional configurations and policy linkages within NIS frameworks directly or indirectly support progress on SDG targets. This conceptual and methodological dispersion limits the field’s cumulative knowledge base and weakens its ability to inform coherent policy design.

Moreover, there is a disconnect between the normative ambitions of NIS discourse and the practical realities of SDG implementation (Weerasinghe & Gunawardena, 2024). Policy documents often reference innovation in aspirational terms, but the operational mechanisms through which innovation systems are expected to address development priorities are seldom examined in detail. It remains uncertain whether existing NIS structures are adequately resourced, well-aligned with sectoral SDG strategies, or embedded in the institutional cultures of decision-making. The absence of clear evidence on these linkages leaves a vacuum at the policy interface where high-level commitments must translate into coordinated action across research institutions, private enterprises, and public agencies.

This lack of synthesis presents a significant challenge. Without a consolidated understanding of how NIS frameworks function in relation to SDG goals, policymakers risk designing innovation strategies that are either disconnected from development priorities or misaligned with existing institutional capacities. Furthermore, development partners and researchers may overlook context-specific bottlenecks that inhibit system-wide learning, coordination, or scaling (Yongabo & Göransson, 2022). In the absence of such insights, innovation policy in Sub-Saharan Africa may fail to achieve its full potential not due to lack of intent, but due to a lack of systemic clarity and alignment.

This systematic review seeks to address that problem. By critically mapping the literature at the intersection of NIS and SDG implementation in Sub-Saharan Africa, it aims to uncover the underlying patterns, blind spots, and strategic misalignments that currently hinder innovation's role in sustainable development. The review provides an evidence base for more targeted and effective policy design, grounded in the realities of the region's innovation ecosystems.

Sustainable development

The pursuit of sustainable development has taken on renewed urgency in Sub-Saharan Africa, where countries face the dual challenge of accelerating economic transformation while addressing deep-rooted social and environmental vulnerabilities (Dosso, 2020). In this context, innovation is increasingly viewed not just as a vehicle for growth, but as a foundational mechanism for achieving structural change and long-term resilience (Sube et al., 2025). The 2030 Agenda for Sustainable Development, articulated through the SDGs, offers a comprehensive framework for addressing these multidimensional challenges (Ouma-Mugabe et al., 2024; Ozor et al., 2020). Yet progress across the region remains uneven, constrained by limited institutional capacity, weak innovation ecosystems, and fragmented policy environments (Skorge, 2024).

The NIS framework offers a promising lens through which to examine these development dynamics. It shifts the focus from individual technologies or firms to the broader configuration of institutions, actors, and policy instruments that enable or inhibit innovation within a national context (Ndicu, 2023; Ogwu, 2025). As conceptualised by Lundvall (1992), Nelson (1993), and others, NIS theory emphasises systemic interactions, knowledge flows, and the role of learning in driving innovation performance. While the framework has traditionally been applied in industrialised countries, it is increasingly used to analyse the innovation capacity of low- and middle-income economies, including those in Sub-Saharan Africa (Ogwu, 2025).

In parallel, the SDGs represent a multidimensional and globally endorsed policy agenda, addressing issues as diverse as education, health, climate action, governance, and infrastructure (Nenni et al., 2024; Nwokolo et al., 2024; Roger et al., 2022). Innovation features prominently in this agenda not only in SDG 9 (Industry, Innovation and Infrastructure), but as a cross-cutting enabler of progress across multiple goals. The United Nations and its development partners have repeatedly highlighted the importance of building national innovation capacity to meet the SDGs (Baita & Suleiman, 2021). However, what remains underexplored is how NIS frameworks have been operationalised in Sub-Saharan Africa to support SDG implementation.

Although scholarship on NIS and SDGs has expanded in recent years, much of it remains siloed, thematic, or descriptive. There is a lack of synthesis that bridges the two domains in a way that allows for comparative insight, policy relevance, and critical reflection. In particular,

it is unclear how innovation systems in Sub-Saharan Africa are contributing to sustainable development outcomes, how well they are aligned with national SDG priorities, and what institutional configurations are proving most effective in this regard.

This paper addresses that gap through a systematic review of literature published between 2020 and 2025, using peer-reviewed articles and high-quality grey literature sourced from Scopus and Google Scholar (Chaudhuri, 2022; Chirambo, 2021; Diop & Asongu, 2024; Haldar et al., 2023; Lambert & Deyganto, 2024). By focusing on this recent period, the review captures post-Agenda 2030 innovation discourse, as well as policy shifts following the COVID-19 pandemic; a period that has placed significant demands on national innovation capacity (Moleka, 2024).

By synthesising this body of work, the paper contributes to the broader agenda of aligning innovation policy with sustainable development imperatives. It offers conceptual clarity for researchers, operational insight for practitioners, and strategic guidance for policymakers working to harness innovation as a lever for inclusive and transformative development in the African context.

Objectives of the Study

This study is designed to achieve the following objectives;

- i. To synthesize scholarly literature on how national innovation systems (NIS) contribute to the achievement of the sustainable development goals (SDGs) in Sub-Saharan Africa.
- ii. To examine the extent to which policy recommendations emerging from NIS studies in Sub-Saharan Africa are aligned with SDG implementation strategies.

Methods

This systematic review was conducted in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines, which provide a structured framework for conducting evidence reviews with transparency, methodological rigor, and replicability. The PRISMA approach ensures that each stage of the review process from search strategy and screening to inclusion criteria and synthesis is clearly documented and can be reproduced or extended by other researchers (Haddaway et al., 2022).

The review process consisted of four key phases:

- Identification of relevant studies through systematic database searches;
- Screening of titles and abstracts to exclude clearly irrelevant works;
- Eligibility assessment through full-text reviews against pre-defined inclusion and exclusion criteria.
- Inclusion of eligible studies for final synthesis and analysis.

This method allowed for a consistent and unbiased selection of literature that directly engages with the relationship between NIS and SDGs within the context of Sub-Saharan Africa. Both conceptual and empirical studies were considered, reflecting the interdisciplinary nature of the research landscape. To maintain relevance and capture recent shifts in the field, particularly post-pandemic innovation discourse and SDG implementation trends, the review

focused on literature published between January 2020 and March 2025. This period also aligns with intensified policy attention toward Agenda 2030 and innovation's role in sustainable recovery.

All stages of the review were documented systematically using an Excel-based data extraction sheet and a PRISMA flow diagram, which is presented in the results section. The final synthesis incorporates both qualitative insights and structured thematic coding to identify dominant pathways, recurring gaps, and policy alignment issues in the selected literature.

2. LITERATURE SEARCH

The literature search formed the foundational step of the systematic review process and was designed to capture a broad yet relevant body of academic work on the intersection of NIS and the SDGs within the context of Sub-Saharan Africa. To ensure comprehensive coverage of peer-reviewed and interdisciplinary research, the search was conducted across two major academic databases: Google Scholar and Scopus.

Google Scholar was selected for its extensive indexing of grey literature, working papers, and institutional publications, many of which are particularly relevant for capturing regional research outputs in African contexts. Scopus was chosen due to its high-quality indexing of peer-reviewed journal articles across economics, development studies, innovation policy, and science and technology fields. Together, these platforms allowed for a robust and inclusive search strategy.

The search strategy was carefully constructed using Boolean operators and controlled vocabulary to ensure that all relevant combinations of key terms were captured. The goal was to retrieve studies that explicitly address the linkage between NIS frameworks and the SDGs within Sub-Saharan African countries.

The following search queries were used:

Google Scholar search string:

("national innovation system" OR "national innovation systems" OR "national system of innovation" OR "national systems of innovation") AND ("sustainable development goals" OR "SDGs") AND ("Sub-Saharan Africa")

This search yielded 582 results after initial deduplication.

Scopus search string (applied to title, abstract, and keywords):

TITLE-ABS-KEY (("national innovation system" OR "national innovation systems" OR "national system of innovation" OR "national systems of innovation") AND ("sustainable development goals" OR "SDGs") AND ("Sub-Saharan Africa"))

This search returned 739 records published between January 2020 and March 2025. To maintain temporal relevance and capture current policy and research dynamics, only articles published from 2020 onward were included. This timeframe was selected to reflect the growing institutional focus on SDG acceleration, as well as post-COVID-19 innovation narratives. The search was conducted between June and July 2025, and all results were exported into an Excel-based reference manager for screening and documentation. Duplicates across databases were identified and removed manually. The remaining records were then subjected to a two-stage

screening process (described in Section 5.2), beginning with title and abstract review, followed by full-text assessment. The final number of included studies is reported in the PRISMA flow diagram. This systematic and transparent search strategy ensured broad coverage of the available literature while preserving the focus and specificity required for rigorous synthesis.

3. METHODOLOGY

The screening process was carried out in two main phases: (1) title and abstract screening, and (2) full-text review. This two-step approach was designed to ensure that only studies directly addressing the intersection between NIS and the SDGs in Sub-Saharan Africa were included in the final synthesis.

Phase 1: Title and Abstract Screening

All search results obtained from Scopus and Google Scholar (after deduplication) were first reviewed at the title and abstract level. The purpose of this stage was to quickly eliminate studies that were clearly irrelevant such as those focusing on unrelated topics (e.g., general innovation theory, SDG implementation without reference to NIS, or studies situated outside of the Sub-Saharan African context). Articles that were too broad, conceptualised innovation in purely technological or firm-level terms without systems framing, or referred only vaguely to sustainable development were excluded at this stage. This phase reduced the pool of studies to a manageable subset for full-text review. Screening was guided by a pre-established protocol based on the inclusion and exclusion criteria outlined in Sections 5.3 and 5.4.

Phase 2: Full-Text Review

In the second phase, the remaining studies were assessed in full. Each article was examined to confirm that it:

- Explicitly addressed both NIS and SDGs;
- Focused on a Sub-Saharan African country or the region as a whole;
- Provided sufficient conceptual or empirical grounding;
- Included policy-relevant insights or institutional analysis.

Where relevance was ambiguous, articles were discussed and reviewed twice to ensure consistency in judgement. Studies that met all criteria were included in the final review sample for data extraction and thematic synthesis. Throughout the screening process, a tracking sheet was used to log decisions, reasons for exclusion, and article metadata (author, year, country focus, methodology, key findings). This ensured transparency and allowed for the construction of a PRISMA flow diagram.

Inclusion Criteria

Studies were considered eligible for inclusion if they met all of the following criteria:

- **Publication Period (2020–2025):** Only literature published within this timeframe was included to ensure contemporary relevance, especially considering the accelerating policy focus on innovation systems and SDG alignment in the wake of the COVID-19 pandemic and shifting development priorities.

- **Language (English):** Articles had to be written in English to ensure full comprehension and comparability during the synthesis process.
- **Geographic Focus (Sub-Saharan Africa):** The study must have a primary empirical or conceptual focus on countries within the Sub-Saharan African region. Multi-country analyses were also included if they provided disaggregated insights for the region.
- **National Innovation Systems (NIS):** The article must engage directly with the NIS concept, whether through formal theorization, institutional analysis, or application to sectoral or national contexts. Studies that addressed innovation policy in isolation without systemic framing were excluded.
- **Sustainable Development Goals (SDGs):** The study had to address the SDGs explicitly or engage with development themes clearly aligned with specific SDG indicators (e.g., climate resilience, education, clean energy, health systems, etc.).
- **Type of Study:** Both empirical and conceptual works were considered, including peer-reviewed journal articles, working papers, and high-quality grey literature (e.g., research institute publications, UN agency reports). However, inclusion required that the work demonstrate strong methodological grounding, either through formal empirical design or systematic conceptual reasoning.

Exclusion Criteria

Studies were excluded from the final review if they met any of the following conditions:

- **Lack of Dual Focus:** Articles that examined either innovation systems or the SDGs in isolation without an integrative perspective were excluded. For example, a paper on firm-level innovation without a systemic or national framing, or an SDG evaluation without reference to innovation systems, was not considered eligible.
- **Geographic Irrelevance:** Studies not centered on Sub-Saharan African countries or not providing region-specific insights were excluded. Papers on North Africa, the MENA region, or global analyses without regional disaggregation were excluded.
- **Weak Methodological Basis:** Opinion pieces, editorials, and descriptive reports lacking clear methodological approaches, theoretical grounding, or empirical evidence were excluded to preserve the analytical integrity of the review.
- **Language and Accessibility:** Full-text articles not available in English or inaccessible due to paywalls or repository restrictions were excluded if they could not be reasonably retrieved through institutional access or author correspondence. This information is presented in figure 1.

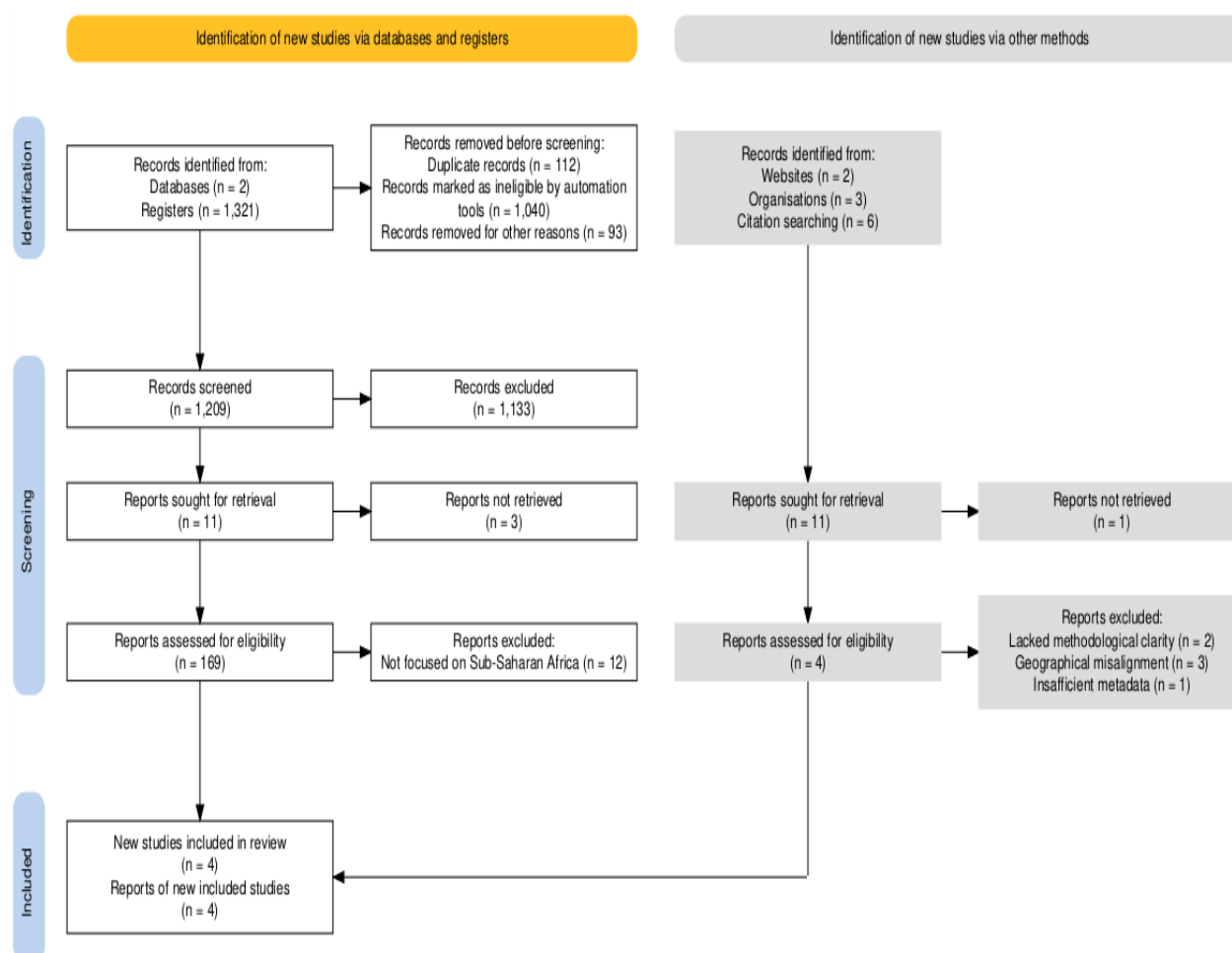


Figure 1: PRISMA Flow Diagram Analysis

4. RESULTS AND DISCUSSION

Table 1 presents a summary of the main features of the 161 studies included in the review. The studies were published between 2020 and 2025, reflecting a contemporary and policy-relevant body of literature. Most of the sources were drawn from Scopus (around 60%), with the remainder accessed through Google Scholar (about 40%). This mix ensured a balance between peer-reviewed, indexed publications and grey or practitioner-oriented literature that may not appear in formal academic databases but still offers valuable insights. All the reviewed studies were published in English, which reflects both the search limitations and the linguistic dominance of English in global research on innovation and development. The studies covered all four major sub-regions of Sub-Saharan Africa; West, East, Central, and Southern although, as discussed elsewhere in the review, regional representation was uneven, with Central Africa comparatively underrepresented.

The types of studies included were diverse. They ranged from empirical analyses; both quantitative and qualitative to conceptual and policy-focused reviews. This allowed for a broader understanding of how NIS are framed, implemented, and evaluated across different contexts. In terms of thematic focus, the dominant sectors represented were agriculture, health, energy, education, climate, and information and communication technology (ICT). These

sectors align closely with several priority areas of the Sustainable Development Goals (SDGs), such as SDG 2 (Zero Hunger), SDG 3 (Good Health), SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), and SDG 13 (Climate Action). Additionally, all included studies had abstracts available, which facilitated consistent screening and eligibility assessment. About 85% of the studies also provided keywords, aiding in thematic coding and categorization during the review process.

5. Table 1: Characteristics of Reviewed Studies

Characteristic	Value
Total Studies Included	161
Publication Period	2020–2025
Sources	Scopus ($\approx 60\%$), Google Scholar ($\approx 40\%$)
Languages	English only
Regions Covered	All Sub-Saharan sub-regions (West, East, Central, Southern)
Types of Studies	Empirical (quantitative & qualitative), Conceptual reviews
Dominant Sectors	Agriculture, Health, Energy, Education, Climate, ICT
Availability of Abstracts	100%
Availability of Keywords	$\sim 85\%$

The scatter plot in figure 2 illustrates the annual distribution of reviewed studies on NIS and their link to SDGs in Sub-Saharan Africa, covering the period from 2020 to 2025. The visual trend reveals clear fluctuations in scholarly interest over time. In the early years of 2020 and 2021 the number of publications was relatively low, with each year recording roughly 13 to 15 studies. This pattern suggests that academic engagement with NIS and SDG-related issues in the region was still developing. Researchers may have been in the early stages of framing innovation systems as relevant tools for achieving sustainable development in African contexts.

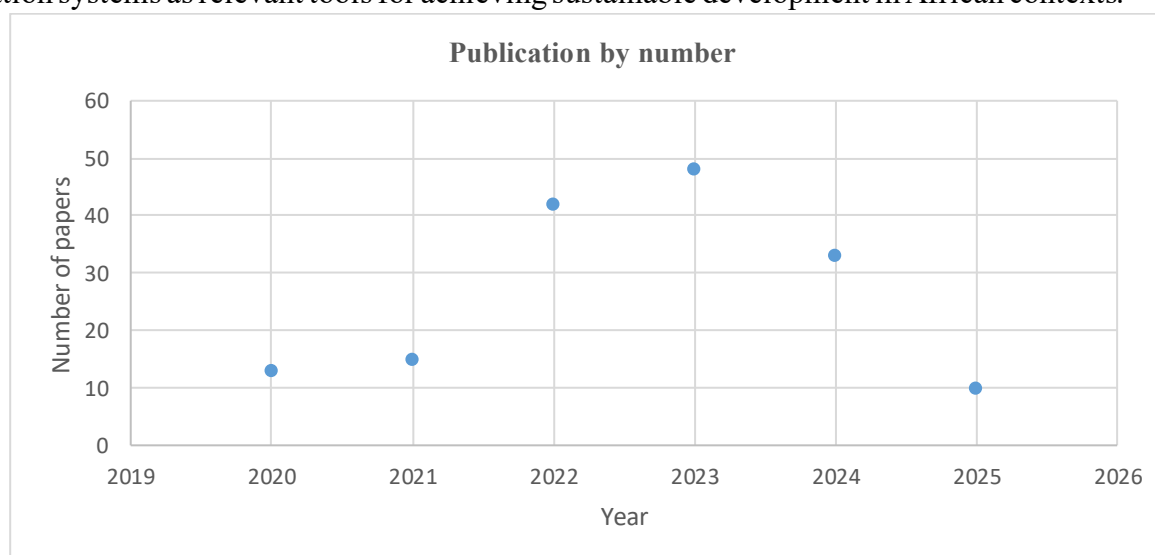


Figure 2. Publications by year

A notable surge occurred in 2022, with the number of studies rising sharply to over 40. This upward trend continued into 2023, which recorded the highest volume of publications, nearing 50 papers. This peak likely reflects increased attention to innovation-driven development in the wake of COVID-19, as many countries and funding agencies emphasized technology, resilience, and systems thinking in their recovery efforts. In 2024, the number of publications dropped to about 33. While this marked a decline from the peak, it still indicated stronger engagement compared to the early years. The decrease may point to a shift in research funding or publication cycles, though interest in the topic remained relatively strong.

By 2025, the number of published studies fell to around 10. This steep drop is likely influenced by the fact that data for 2025 were only partially available at the time of the review. It may also reflect changing academic priorities or delays in the publication pipeline. Overall, the pattern suggests that research on NIS and SDGs gained momentum significantly between 2020 and 2023, with some variation in output in the years that followed.

Figure 3 shows the distribution of reviewed publications by the country of the corresponding author or research affiliation. The chart provides insights into where most of the research on NIS and SDGs in Sub-Saharan Africa is being produced or led from. The data reveal a significant concentration of publications in two categories: "Others" and China. The "Others" category dominates the chart, with close to 60 papers, suggesting a wide range of contributions from countries not individually listed; including many African nations and smaller contributors globally. This indicates that while some research is concentrated in leading countries, a large portion of the work is also being carried out across a dispersed set of institutions worldwide.

China is the single most represented named country, contributing over 40 papers. This reflects China's growing academic engagement with development and innovation systems in Africa, possibly linked to its broader investment and cooperation strategies on the continent. Among Western countries, the United Kingdom shows the highest contribution, followed by France, Germany, Portugal, and Ukraine. Each of these countries contributed between 5 and 15 papers, highlighting their moderate but meaningful involvement in the scholarly discourse. The strong showing from countries like the UK and France may be linked to historical ties with Sub-Saharan Africa, existing research networks, and donor-funded academic collaborations. Meanwhile, Portugal and Ukraine have a smaller footprint but still demonstrate some presence.

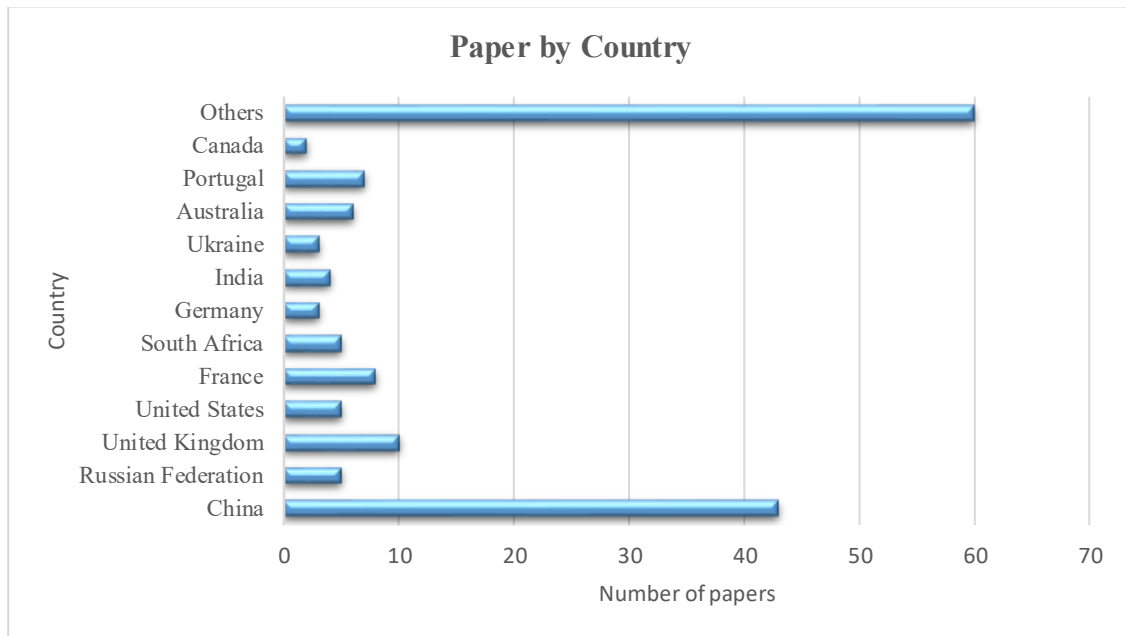


Figure 3: Publications by country

Figure 4 presents a pie chart illustrating the distribution of reviewed studies by their source of publication. This visualization sheds light on the academic platforms where research related to NIS and the SDGs in Sub-Saharan Africa is most frequently disseminated. The data reveals a diverse publication landscape, reflecting the cross-disciplinary nature of the topic. The largest proportion of papers; 39% originated from journals or outlets categorized as “others.” These include a broad mix of publications not explicitly listed in the chart, likely spanning interdisciplinary journals. This wide distribution suggests that NIS–SDG research does not reside in one disciplinary silo, but rather is spread across multiple knowledge domains, including science policy, development studies, innovation management, and sustainability research. Among the specifically identified journals, studies in science of science accounts for 17% of the total publications. This highlights the influence of science and technology studies in shaping discussions around innovation systems, particularly through a systems-thinking lens. Innovation and development follow with 13%, underscoring the growing scholarly interest in how innovation drives economic transformation in low- and middle-income regions, including Sub-Saharan Africa. The Journal of the knowledge economy represents 12% of the sample. This journal’s contribution reflects an emphasis on the role of knowledge creation, diffusion, and application in building innovation-led economies. Sustainability Switzerland, which contributes 11%, indicates the increasing tendency to frame innovation within broader sustainability and environmental goals, especially in light of the 2030 Agenda.

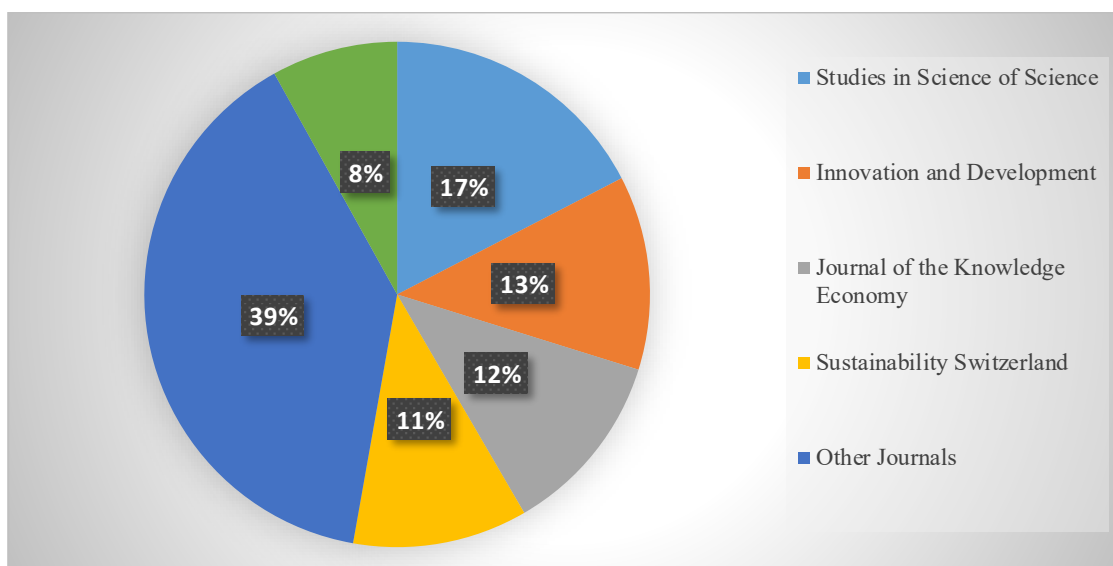


Figure 4. Publications by source

Finally, an additional 8% of publications come from other sources not explicitly named in the legend but still relevant to the research field. The variety of publication outlets shown in Figure 4 demonstrates the complexity and reach of NIS–SDG research, confirming its importance

Figure 5 shows the number of reviewed publications attributed to individual authors. The graph highlights the contribution levels of selected scholars to the body of research on NIS and SDGs in Sub-Saharan Africa. The most notable feature of the chart is the sharp spike associated with the "Others" category, which represents over 100 publications. This indicates that the majority of the papers included in the review were authored by a wide and diverse group of scholars who each contributed only a few papers. This pattern suggests that the field is broad, with many voices contributing, but few dominant authors leading the discourse.

For the named authors, the number of publications per individual ranges between approximately 3 and 10 papers. Authors such as Casadevall, V., Chen, J., Lundvall, B.Å., and Secka show consistent contributions, though at modest levels. These individuals represent key contributors who have engaged repeatedly with the NIS–SDG research agenda. For instance, Lundvall, B.Å. is widely known for foundational work in innovation systems theory, and his presence in this list underscores the theoretical grounding of many included studies. Authors such as Chen K., Chen J., Lee K., and Volchik, V.V. also appear among the contributors, reflecting international collaboration and multidisciplinary engagement in the topic. The relatively even distribution among individual authors (excluding the "Others" category) suggests that research on NIS and SDGs in Sub-Saharan Africa has yet to consolidate around a small set of influential scholars and remains open and diverse across multiple scholarly conversations and policy arenas.

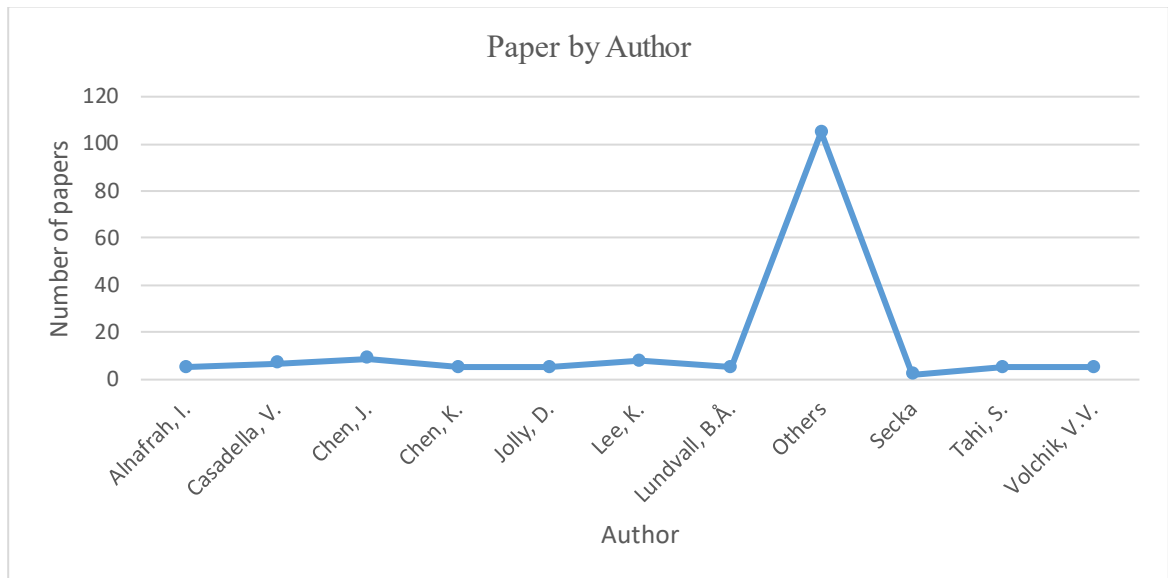


Figure 5. Publications by author

Key Findings of Reviewed Papers

Objective One

To synthesize scholarly literature on how National Innovation Systems (NIS) contribute to the achievement of the Sustainable Development Goals (SDGs) in Sub-Saharan Africa.

The review found a growing number of studies examining how National Innovation Systems (NIS) relate to the Sustainable Development Goals (SDGs) in Sub-Saharan Africa. However, the depth and consistency of this research remain uneven. Most studies describe NIS as a helpful concept for organizing innovation across different sectors. Yet, many of these studies do not explain clearly how innovation systems are built or how they function in practice within African countries (Secka & Johnson, 2023). Instead, they often borrow ideas developed in OECD countries without adapting them fully to African realities (Chirambo, 2021). As a result, there is little operational detail in many of the studies. Few explain how NIS is measured, what institutions are involved, or how outcomes are tracked. Some recent work is trying to fill this gap. For example, Jjagwe et al. (2024) examine how resilience and transformation are shaped by NIS in Uganda. Their study highlights the role of institutional linkages and capacity in delivering innovation outcomes, especially in agriculture and energy. Still, such detailed studies are rare. Many countries lack national innovation audits or regular reporting on how innovation systems support the SDGs. This makes it difficult to compare across countries or track long-term progress.

Evidence of how National Innovation Systems (NIS) support the Sustainable Development Goals (SDGs) was strongest in applied sectors. In these sectors, innovation outcomes could be clearly seen and linked to real-world impacts. Agriculture, which relates to SDG 2 (Zero Hunger), stood out across many studies. Researchers, universities, and agritech firms have developed new ways to improve food production and build resilience to climate change. In some countries, digital tools and localized innovation hubs have helped smallholder farmers access better information and inputs (Jjagwe et al., 2024). However, these efforts often happen in isolation. Many actors work in parallel rather than through a coordinated national system.

The energy sector also showed clear examples of innovation linked to SDG 7 (Affordable and Clean Energy). In particular, off-grid renewable energy technologies like solar mini-grids and mobile pay-as-you-go systems have expanded access in rural communities. These innovations are often driven by public–private partnerships and supported by donor programs, yet the role of national innovation systems in scaling them remains underdeveloped (Akhtar-Schuster et al., 2024).

There were also examples of innovation contributing to SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education). For instance, digital health platforms have helped improve service delivery in remote areas. Similarly, online education tools have been used to support teacher training and reach learners during school closures. These efforts reflect how evolving innovation systems can influence health and education outcomes (Mugabe et al., 2022). Still, much of the evidence in these sectors remains anecdotal. Many studies describe what is happening but do not track long-term impacts or connect these activities to broader NIS frameworks.

The link between NIS and inclusive economic growth, which falls under SDG 8, is mentioned in many studies. However, the evidence is often weak or incomplete. Most papers argue that innovation systems can support job creation, improve productivity, and help move economies away from low-value sectors (Chirambo, 2021; Diop & Asongu, 2024; Lukman et al., 2023; Ndicu et al., 2023; Nwokolo et al., 2024; Secka, 2023). But very few studies use strong data or models to test these claims (Machado et al., 2024). There is a lack of causal analysis showing how NIS leads to long-term economic outcomes. This makes it hard to understand whether innovation is driving broad-based development or just producing isolated success stories.

One major issue is that innovation systems in the region are not well connected (Akhtar-Schuster et al., 2024; Baita & Suleiman, 2021; Nenni et al., 2024; Yigit, 2021). Many countries have weak coordination between key actors such as universities, research centers, government ministries, and private firms (Adenle et al., 2020; Chaudhuri, 2022; Chaves-Chaparro et al., 2025; Daniels et al., 2022; Hamidi & Berrado, 2024; Jjagwe et al., 2024; Narayanan et al., 2024; Nenni et al., 2024; Secka, 2023). This disconnect limits the ability of innovation systems to scale ideas or transfer knowledge across sectors (Chirambo, 2021). In many cases, policies are fragmented, and projects are short-term. These conditions make it difficult to build learning systems or attract long-term investment in research and development (Adekolu, 2022; Adenle et al., 2023; Daniels et al., 2020; Dosso, 2020; Leo, 2022).

A few countries such as South Africa, Kenya, Nigeria, and Ghana have made some progress in aligning innovation policies with SDG priorities (Leo, 2022; Ndicu, 2023; Ngoasong et al., n.d.; Skorge, 2024; Suárez & Erbes, 2021). These countries have developed national strategies that mention innovation and include links to sustainable development plans. However, even in these cases, policy documents often lack clear coordination mechanisms or monitoring systems. As a result, there is still a large gap between planning and action (Akhtar-Schuster et al., 2024). While the ambition to use innovation to achieve the SDGs is growing, the institutional frameworks to make it happen remain weak or underdeveloped across much of Sub-Saharan Africa.

Objective Two

To examine the extent to which policy recommendations emerging from NIS studies in Sub-Saharan Africa are aligned with SDG implementation strategies.

The review found that only a small number of studies in Sub-Saharan Africa clearly link innovation system policies to specific SDGs. While most papers mention the SDGs in general terms, few offer detailed guidance on how innovation policy can help achieve individual goals like education, energy, or industry (Akhtar-Schuster et al., 2024; Baita & Suleiman, 2021; Chirambo, 2021; Nenni et al., 2024). In many cases, the connection between NIS and the SDGs is broad and aspirational, without clear steps or indicators for implementation (Baita & Suleiman, 2021). Some studies stress the importance of aligning national innovation policies with global development goals. However, most fall short of explaining how this alignment should happen in practice. For example, strategies often mention support for technology, research, or entrepreneurship, but do not show how these actions are expected to improve outcomes related to poverty, inequality, or sustainability (Mosupye-Semenya, 2024; Mugwagwa et al., 2022; Pavesi, 2022; Skorge, 2024; Tigabu & Khaemba, 2020). Without this kind of clarity, it is difficult for policymakers to know whether their innovation efforts are contributing to SDG progress (Krishna & Lorsuwannarat, 2024).

This gap suggests that more work is needed to integrate SDG frameworks into innovation policy design. It also shows the importance of developing tools that help track progress and adjust policies over time. Currently, these tools are either missing or underused in most of the studies reviewed. A common issue raised across the studies is the lack of effective institutional coordination between government ministries and agencies (Mugwagwa et al., 2022; Ngoasong et al., n.d.; Ouma-Mugabe et al., 2024; Secka, 2023; Sube et al., 2025). Many papers point out that departments responsible for science and technology, education, economic planning, and environmental management often work in silos. This separation leads to overlapping responsibilities and scattered efforts. As a result, innovation policies are not always aligned with national development strategies or SDG targets (Akhtar-Schuster et al., 2024).

Several studies call for better cooperation between institutions (Ouinso & Chabossou, 2024; Secka, 2023; Skorge, 2024; Sube et al., 2025; Tigabu & Khaemba, 2020; Yongabo, 2021). They suggest that innovation planning should involve multiple sectors and stakeholders, including universities, private firms, local governments, and civil society. However, while the need for coordination is often emphasized, most studies do not explain how this coordination should be achieved. There is little discussion of the specific tools, platforms, or governance structures that would help bring actors together (Chirambo, 2021). Without clear institutional arrangements, many innovation policies remain disconnected from national planning. This makes it difficult to track their impact or ensure that they support long-term development goals.

Many of the policy recommendations across the reviewed studies focus on three main areas. First, they highlight the need to build technical and institutional capacity. Second, they call for more public investment in research and development. Third, they stress the importance of better coordination among government agencies and stakeholders. These priorities are widely shared. However, most studies offer only general suggestions. They do not explain how these actions should be implemented or how success should be measured over time (Krishna & Lorsuwannarat, 2024; Jjagwe et al., 2024).

Only a small number of papers present clear strategies for tracking the long-term effects of innovation policies on SDG outcomes. This makes it difficult to know which interventions are working and which ones need improvement. Without proper evaluation systems, innovation planning remains reactive rather than strategic. At the same time, some studies highlight new and promising models. There is growing interest in decentralized and cross-sectoral innovation approaches. These include digital health programs, regional innovation hubs, and agro-innovation zones. Such efforts often bring together local governments, universities, startups, and international partners (Mugabe et al., 2022). These models reflect the complexity and diversity of innovation in the region. However, they are often small in scale. Most operate as pilot projects and are not yet linked to broader national policies. Because of this, their potential to support SDG progress is not fully realized.

A major challenge highlighted in the literature is the lack of strong monitoring and evaluation (M&E) systems. Most countries do not have clear indicators to track how innovation policies are contributing to SDG progress. Few studies use long-term data, and many rely on short-term case examples. This makes it difficult to see whether innovation systems are having a sustained impact (Secka & Johnson, 2023). Without good data, policymakers cannot make informed decisions, and there is little accountability for results. This weak evaluative capacity limits learning. If governments do not know what is working, they cannot adjust their strategies to meet new challenges. This gap also affects how innovation is funded and scaled. Donors and national planners need evidence to support long-term investment, but that evidence is often missing or unreliable (Krishna & Lorsuwannarat, 2024).

The idea that innovation systems can help achieve the SDGs is now widely accepted in policy discussions. However, there is still a disconnect between this recognition and what is happening in practice. Many innovation policies are not linked to SDG plans. Even when they are, there is little coordination across institutions, and the systems to track progress are weak. To fix this, countries will need to invest in better frameworks, support long-term learning, and build stronger links between sectors (Akhtar-Schuster et al., 2024; Chirambo, 2021).

Discussion

This review shows that the national innovation system (NIS) framework is not being used fully to support the sustainable development goals (SDGs) in Sub-Saharan Africa. Many countries talk about innovation in their development plans, but few treat it as a system that connects people, institutions, and knowledge. In most cases, innovation is mentioned as a goal, not as a strategy or structure to guide action (Chirambo, 2021).

Studies reveal that innovation is often handled in a fragmented way. Ministries, agencies, and research institutions work separately. This limits collaboration and slows progress. While some national policies refer to innovation as part of broader development, they do not clearly explain how innovation systems will help achieve specific SDG targets (Secka & Johnson, 2023). The connection between NIS and SDG strategies is weak or missing in most countries.

This gap matters because innovation needs coordination. Without strong links between actors such as universities, private firms, and public agencies, innovation cannot grow or have lasting impact. This review confirms that many countries still lack this kind of system-wide thinking, which is necessary for innovation to support long-term development goals (Jagwe et al., 2024). A major issue that appears across many studies is the weakness of institutions

involved in innovation. Government ministries, universities, research organizations, and private companies often do not work well together. This lack of coordination slows innovation and makes it harder to solve big development problems. Many studies agree that stronger institutions and better partnerships are needed. However, they differ in how to get there. Some suggest national strategies led by central government. Others argue for local or sector-based approaches that respond to specific challenges on the ground (Chirambo, 2021; Secka & Johnson, 2023).

One new idea that shows promise is the modular sub-system approach. This method involves building smaller innovation systems that focus on a specific sector, such as agriculture, energy, or health. Each sub-system can be shaped by local needs but still link back to a national innovation plan. For example, an agricultural innovation hub in a rural area may work with local farmers, researchers, and businesses but also connect to national research funding or export goals (Jagwe et al., 2024). This model is flexible and can work well in countries where governance is decentralized or where resources are unevenly distributed. Despite its potential, few countries have adopted this approach in a meaningful way. Many pilot programs remain small and disconnected from national policy. Problems like unclear leadership, low funding, and weak technical skills make it hard to grow these efforts. Political support is also lacking in many places. Without clear plans and strong follow-through, modular systems risk staying small and failing to influence national development (Akhtar-Schuster et al., 2024).

Another major challenge found in the literature is the weak state of monitoring and evaluation (M&E) systems. Most countries in Sub-Saharan Africa do not have proper tools to measure how their innovation systems affect SDG outcomes. Very few studies mention system-wide indicators or long-term data collection. Without this information, it becomes hard to assess progress or learn from experience. This lack of data also makes it difficult for governments to make smart investment decisions in research and innovation (Secka & Johnson, 2023; Krishna & Loruswannarat, 2024). National development plans often talk about innovation, but mostly in broad terms. They rarely include measurable targets, timelines, or assigned funding for M&E. Because of this, innovation is hard to manage and even harder to evaluate. Policymakers are left without the evidence they need to improve strategies or respond to emerging challenges (Machado et al., 2024).

There is also a clear imbalance in where the research is coming from. Most studies focus on countries like South Africa, Kenya, Nigeria, and Ghana. These countries have stronger research systems and more developed innovation policies. But other regions, especially Central Africa and post-conflict states, are often missing from the literature (Akhtar-Schuster et al., 2024). This creates a gap in understanding. Important innovations happening in underrepresented countries may go unnoticed, and the findings from more studied countries may not apply everywhere. This uneven coverage limits what we can learn from the region as a whole. To improve future research, more attention must be given to countries with weak institutional capacity, fragile settings, or unique innovation challenges. A more balanced and inclusive research base is needed to capture the full picture of NIS and SDG progress in Sub-Saharan Africa.

Recommendations

To strengthen the role of National Innovation Systems (NIS) in achieving the Sustainable Development Goals (SDGs) in Sub-Saharan Africa, several key actions are recommended.

These actions aim to address the gaps in coordination, implementation, monitoring, and inclusivity that were identified throughout this review.

One of the most promising strategies is the adoption of modular innovation sub-systems. Instead of building overly broad and centralized systems, governments should focus on creating smaller, sector-specific innovation units that are easier to manage and better suited to local needs. For example, innovation sub-systems can be built around specific sectors such as climate-smart agriculture, maternal health, renewable energy, or digital education. These modular systems allow different regions and communities to develop context-appropriate solutions while still linking to national innovation and development strategies. They can also act as testbeds for innovation, where successful models can later be scaled up or replicated in other sectors. Countries such as Uganda and Kenya have already seen some success with sector-focused innovation hubs, particularly in the areas of agriculture and ICT.

Another critical recommendation is the need to improve the alignment between innovation strategies and national SDG implementation plans. Too often, innovation is treated as a standalone policy area rather than a cross-cutting driver of development. To correct this, governments must define clear SDG-linked goals within their innovation frameworks. These goals should come with measurable indicators, set timelines, and assigned resources. When innovation policies are directly tied to development targets such as reducing maternal mortality, increasing access to clean energy, or improving food security their relevance and impact become clearer to both policymakers and citizens. Countries like Ghana and South Africa are beginning to move in this direction, but many others have yet to make this shift (Akhtar-Schuster et al., 2024).

Robust monitoring and evaluation (M&E) systems are also essential. Without good data, it is impossible to track whether innovation systems are making a real contribution to the SDGs. Governments should prioritize the creation of standardized metrics that can capture innovation inputs, processes, and outcomes. This involves building institutional capacity to collect and analyze data regularly and use it to improve policy design. An evidence-based approach helps identify what is working, where support is needed, and how to allocate resources more effectively (Secka & Johnson, 2023). Additionally, well-designed M&E systems increase transparency and accountability, which can help build public and political support for innovation funding.

Cross-sector learning and integration should also be promoted. Innovation does not happen in isolation. It often occurs at the intersection of different sectors, such as when digital tools are used in education or when environmental policies support new farming techniques. Governments and donors should create formal platforms that allow for collaboration across ministries, research institutions, civil society, and the private sector. These can include shared innovation hubs, joint funding schemes, or cross-ministerial taskforces. By encouraging collaboration, these mechanisms reduce duplication, foster creativity, and accelerate progress toward shared development goals (Chirambo, 2021).

Finally, it is important to strengthen regional research networks. Much of the current evidence on NIS in Africa comes from a few Anglophone countries with relatively strong institutions. Central Africa, Francophone countries, and post-conflict states remain underrepresented. Donors and research institutions should support more inclusive and

comparative studies that explore how innovation systems function in different political, cultural, and economic contexts. Supporting regional networks can help surface homegrown innovations that are not yet visible in global or academic platforms. They can also promote peer learning and help policymakers adapt successful practices from neighboring countries to their own settings (Krishna & Lorsuwannarat, 2024).

Strengthening the contribution of NIS to sustainable development in Sub-Saharan Africa requires bold policy changes, sustained investment, and a commitment to learning. By adopting modular systems, aligning innovation with SDG targets, improving data systems, fostering integration, and promoting inclusive research, countries can unlock the full potential of innovation as a tool for development.

5. CONCLUSION

National Innovation Systems (NIS) serve as a valuable framework for understanding how innovation can drive sustainable development in Sub-Saharan Africa. They provide a structured way to connect the efforts of governments, research institutions, private firms, and civil society toward common development goals. In theory, a well-functioning NIS supports knowledge generation, technological diffusion, and institutional learning; three elements that are crucial for achieving the Sustainable Development Goals (SDGs) (Jjagwe et al., 2024). However, the findings from this review suggest that most countries in the region have not fully embraced or operationalized this approach.

While some countries have made progress, especially in sectors like agriculture, energy, health, and education, these efforts are often limited in scope and poorly linked to national SDG strategies. For example, digital health initiatives and off-grid renewable energy systems have improved local service delivery and access, but these innovations typically occur in isolation or through externally driven pilot projects. They are not yet embedded within comprehensive, government-led innovation systems (Mugabe et al., 2022). This pattern points to a broader institutional problem: many national innovation systems remain fragmented, with unclear governance structures, weak coordination, and minimal alignment between innovation policies and SDG implementation plans (Chirambo, 2021).

To strengthen the effectiveness of NIS, countries in the region must move from rhetoric to practice. This shift will require deliberate investments in governance, policy design, and institutional capacity. Building robust innovation systems means creating platforms that allow actors to collaborate across sectors, track performance with meaningful indicators, and adapt to local needs and resource constraints. Countries will need to develop long-term innovation strategies that are not only ambitious but also flexible and grounded in evidence. This includes supporting monitoring and evaluation tools, ensuring policy continuity across political cycles, and fostering inclusive participation from both public and private stakeholders (Secka & Johnson, 2023; Krishna & Lorsuwannarat, 2024).

Equally important is the need to recognize and address the regional disparities in innovation capacity. While countries like South Africa, Kenya, and Ghana are relatively advanced, many others particularly in Central Africa and post-conflict states; lack the basic infrastructure and institutional environment needed to support innovation-led development. Without targeted support, the NIS framework may deepen existing inequalities rather than reduce them.

The potential of National Innovation Systems to accelerate progress toward the SDGs in Sub-Saharan Africa remains significant but unrealized. The framework offers a powerful lens for aligning knowledge, technology, and development policy. Yet, its promise can only be fulfilled if countries commit to building inclusive, data-driven, and well-governed innovation ecosystems. Innovation is not a side project; it is central to sustainable development. If better designed and better implemented, NIS can serve as a foundation for achieving transformative and equitable growth across the region.

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