Volume 5, Issue 2, December 2025 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2025.05.1.1364

Sustainable Green Motorized Transportation in Africa: A Systematic Review of Challenges, Innovations, and Policy Interventions

Enock Musau Gideon

University of Johannesburg, South Africa And Kisii University, Kenya

egiddy14@gmail.com

Received on: 22 May 2025 **Accepted on: 01 July 2025** **Published on: 10 September 2025**

Abstract

***Purpose**: This study systematically explores how industrialization and policy interventions, alongside social, technological, and economic dimensions, influence the transition toward sustainable green motorized transportation in Africa. The objective is to provide an integrated understanding of the multi-level factors shaping the adoption and scalability of environmentally friendly transport systems.*

***Design/methodology/approach:** A systematic literature review was conducted using the PRISMA framework, encompassing 41 peer-reviewed studies published between 2015 and 2024. The analysis employed bibliometric screening, thematic synthesis, and quality appraisal using MMAT and CASP to ensure methodological rigor and minimize bias.*

***Findings:** The review reveals that fragmented policy ecosystems, limited industrial capacity, and inadequate stakeholder engagement are major barriers to green mobility transitions in Africa. Additionally, social acceptance, technological readiness, and economic viability significantly influence the scalability of green motorized transport initiatives. Case examples from Rwanda, Ghana, Kenya, and South Africa demonstrate varying degrees of progress and implementation gaps.*

***Research implications/limitations:** The study provides a conceptual and theoretical synthesis that is useful for future research. However, it is limited by the exclusion of grey literature and language restrictions to English, which may omit relevant regional insights and policy documents published in other languages.*

***Practical implications:** Policymakers should prioritize coordinated industrial-policy integration, stakeholder engagement, and local innovation support. The findings offer a roadmap for African governments, private investors, and development partners to design context-specific, inclusive, and financially viable green transportation strategies.*

***Originality:** This review makes a novel contribution by linking industrialization, policy, and multi-dimensional enablers using the Socio-Technical Transitions Theory. It moves beyond siloed perspectives to propose an integrated framework for understanding and operationalizing sustainable transportation in the African context.*

***Keywords:** Sustainable, Green, Motorized Transportation, Industrialization, Policy*

Volume 5, Issue 2, December 2025 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2025.05.2.1364

Introduction:

The current status of sustainable green motorized transportation in Africa is gaining increasing attention due to rapid urbanization, population growth, and rising transportation demands. Literature in this domain underscores Africa's pressing need to adopt sustainable practices in motorized transportation to combat environmental impacts, reduce carbon emissions, and foster sustainable development.

Numerous studies highlight the pivotal role of industrialization in propelling the adoption and implementation of sustainable green motorized transportation technologies in Africa. For example, Okereke et al. (2020) assert that governments must exhibit unwavering commitment to a greening agenda during rapid industrialization. Their study emphasizes the aspirations of certain African nations, including Ethiopia, Rwanda, and Mauritius, to transition to green economies by decoupling industrialization from environmental repercussions. Sovacool et al. (2022) posit that industrialization in African cities leads to increased urbanization and a shift toward green transportation technologies. Their study delves into three innovations: electric mobility, ridesharing and bike-sharing, and automated vehicles in the urban centers of Kigali (Rwanda), Nairobi (Kenya), Johannesburg (South Africa), and Lagos (Nigeria).

Policy frameworks and interventions are pivotal in driving sustainable green motorized transportation in Africa. Galuszka et al. (2021) underline the significance of policy interventions in creating a conducive environment for sustainable transportation practices. They spotlight the growing number of policies promoting electric mobility principles, particularly in Kenya and Rwanda. Heyns and Luke (2016) underscore South Africa's comprehensive National Development Policy, outlining the transition to a greener economy through various strategies, frameworks, and Acts. The policy framework for greening industrialization in Africa underscores the need for unwavering commitment to an inclusive, green transformation of African economies (Ahmad et al., 2022).

However, despite the escalating interest in sustainable green motorized transportation in Africa, notable gaps in existing literature warrant further exploration. First, the transportation sector predominantly relies on fossil fuels, which substantially contribute to greenhouse gas emissions and environmental degradation, jeopardizing the region's sustainable development goals (Fayiga et al., 2018). Second, there is a lack of in-depth studies regarding the current state of infrastructure development for sustainable transportation systems. While some studies touch upon the importance of transportation infrastructure (Hlotywa & Ndaguba, 2017; Njoh, 2012), further research is essential to evaluate the extent and quality of infrastructure in African countries supporting green motorized transportation.

Third, research addressing the specific challenges and barriers industries face in promoting sustainable green motorized transportation remains scarce. Existing literature often focuses on benefits and opportunities (Mwampamba et al., 2013; Oyekunle, 2017) without thoroughly addressing practical obstacles, such as limited financial resources, technology transfer barriers, and market dynamics. Investigating these challenges, alongside examining the roles of industrialization and policy, is vital for fostering sustainable transportation practices within Africa's industrial sector.

Lastly, a comprehensive evaluation of the effectiveness of existing policy frameworks and interventions is lacking. While some studies touch upon policy initiatives for greening transportation (Musakwa & Gumbo, 2017; Yaro, 2015), there is a need for systematic assessments of their impact on promoting sustainable green motorized transportation. This evaluation includes examining the alignment between policy objectives and outcomes, assessing the level of implementation and enforcement, and identifying gaps and areas for improvement. This systematic review offers a comprehensive analysis of the current state of sustainable green motorized transportation in Africa, specifically focusing on the roles of industrialization and policy frameworks in addressing these gaps. Through the synthesis of existing literature, this study aims to fill these voids, provide insights into infrastructure development, industry challenges, and policy effectiveness, and present recommendations to enhance sustainable transportation practices in Africa.

What distinguishes this review from existing literature is its integrated focus on the triadic relationship between industrialization, policy interventions, and the adoption of sustainable green motorized transportation in Africa. While previous reviews have examined either green transport technologies or policy dimensions separately, this review offers the first holistic synthesis that links industrial growth patterns with policy effectiveness and technological adoption. This contribution helps to close a critical gap in understanding how sustainable transport systems can evolve within the context of Africa's development priorities.

The research question guiding this systematic review is, "What is the impact of industrialization and policy interventions on the development and implementation of sustainable green motorized transportation in Africa?" By addressing this research question, the systematic

Volume 5, Issue 2, December 2025 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2025.05.1.1364

review provides a comprehensive understanding of the interplay between industrialization, policy interventions, and sustainable green motorized transportation in Africa.

Subsequent sections of this paper present a detailed methodology, followed by a comprehensive literature analysis, key findings, and implications. The paper concludes by discussing recommendations and opportunities for future research to advance sustainable green motorized transportation in Africa.

Proposed conceptual framework

The conceptual framework in Figure 1 provides a comprehensive lens for understanding the critical determinants of sustainable green motorized transportation in Africa. At its core, the model emphasizes five interdependent drivers: industrialization (Odiyo et al., 2021; Oni & Longe, 2024), policy interventions (Bikam, 2021; Moalosi et al., 2024), technological advancement (Bikam, 2021; Bokopane et al., 2020), social acceptance (Adjei et al., 2023; Moeletsi, 2021), and economic viability (Chigbu & Umejesi, 2024; Odiyo et al., 2021). These components collectively shape the continent's transition toward greener mobility systems. Industrialization supports the local development and production of eco-friendly transport technologies through infrastructure development (Kuklina et al., 2021), economic growth (Patnaik, 2018), sustainable policies and technological advancements (Han et al., 2023; Hoseinzadeh et al., 2023), and regulatory support (Palaniappan & Vedachalam, 2022).

The framework is further strengthened by three moderating influences: governance quality, donor support, and regional integration, positioned at the top of the model. These elements affect how effectively the primary drivers interact and influence outcomes. Good governance enhances implementation and accountability (Binh & Giai, 2022; Said et al., 2020) by improving regulatory coordination (Brizga et al., 2024; Setyarto et al., 2025) and reducing institutional fragmentation Uddin et al., 2021. Donor support facilitates technology transfer and provides critical financial and technical assistance, particularly where domestic capacity is limited (Huang et al., 2024; Jambadu et al., 2024). Regional integration fosters policy harmonization and cross-border collaboration through platforms such as the African Continental Free Trade Area (AfCFTA), enabling economies of scale in the adoption of green transport innovations, thereby promoting sustainable development across the continent (Aja, 2023; Ajibo, 2023; Vhumbunu et al., 2023).

Importantly, the framework includes feedback loops to capture the dynamic and evolving nature of green transport systems (Hedeler et al., 2023; Suryani et al., 2023). For example, outcomes such as environmental improvement or economic growth feed back into policy refinement and reinvestment in industrial and technological domains (Chatzistamoulou & Koundouri, 2024). Additionally, the model incorporates a temporal perspective by distinguishing short-term, medium-term, and long-term outcomes across environmental, social, and economic dimensions. These include reduced carbon emissions (Garramone et al., 2022), improved air quality and job creation (Larina et al., 2021), inclusive mobility (Stefaniec et al., 2021), and better public health (Alahmadi, 2020).

Overall, this conceptual framework offers a multidimensional perspective for assessing sustainable transportation in Africa by integrating four key theories. The Resource-Based View (RBV) emphasizes leveraging local capabilities and strategic assets to drive green transport innovations. Sustainable Transportation Theory provides a holistic lens focused on balancing environmental, economic, and social objectives in mobility systems. Institutional Theory highlights the influence of formal structures, policies, and norms on transport behavior and adoption, while the Technological Innovation Systems (TIS) theory examines the dynamic interaction among actors, institutions, and markets that support innovation. Together, these theories form a comprehensive foundation for guiding research, policy development, and strategic planning toward sustainable urban and interurban mobility across the continent.

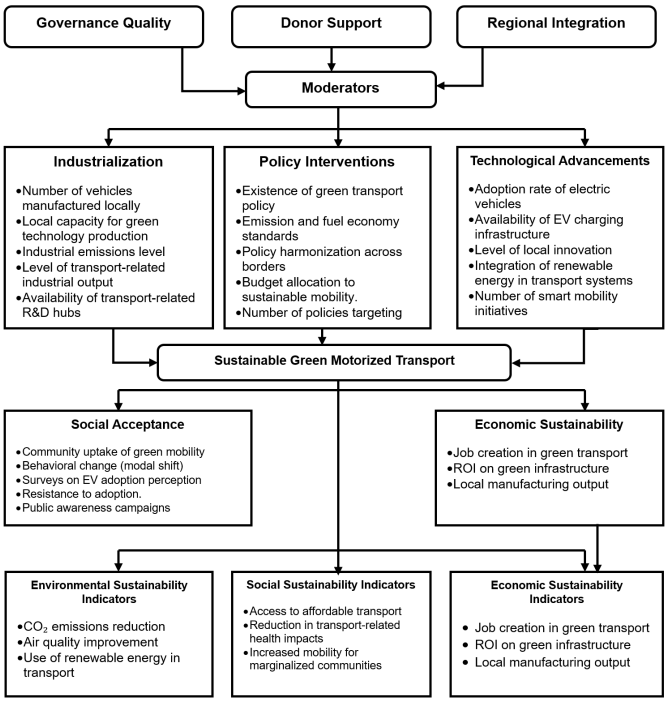

Figure 1: an integrated, dynamic framework for sustainable green motorized transportation in africa

Volume 5, Issue 2, December 2025 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2025.05.2.1364

Theoretical Framework: Socio-Technical Transitions Theory

To provide a structured understanding of how industrialization and policy interventions shape the evolution of sustainable green motorized transportation in Africa, this review is anchored in the Socio-Technical Transitions (STT) theory (Geels, 2005). It emphasizes the co-evolution of technology and society, recognizing the complex interplay between various actors, institutions, and technological innovations (Nora & Alberton, 2021). The STT framework, widely applied in sustainability studies, explains how systemic transformations in sectors like energy, mobility, and infrastructure unfold through the interplay of multiple actors, institutions, and technological innovations (Foxon et al., 2020; Kraff, 2024).

The Theory operates across three analytical levels: landscape, regime, and niche. The landscape level refers to macro-level trends such as demographic shifts, climate change pressures, and global decarbonization imperatives, which exert external pressures on existing systems (Mourner et al., 2022). In the African context, the landscape includes increasing urbanization, international climate commitments, and persistent infrastructure deficits. These pressures compel changes in the prevailing socio-technical regime, which consists of dominant practices, institutions, and technological configurations such as conventional fuel-powered transport systems, underdeveloped emission policies, and fragmented urban planning (Li et al., 2022)

The niche level is where radical innovations such as electric mobility, non-motorized transport systems, or green infrastructure planning emerge and are nurtured through pilot projects, subsidies, and experimental urban labs (Cascetta et al., 2025; Catania et al., 2025). In Africa, these niches include small-scale electric vehicle adoption in cities like Kigali and Cape Town, informal bike logistics, and policy advocacy for inclusive mobility transitions (Galuszka et al., 2021). However, their success depends on aligning niche innovations with favorable policy interventions and industrial readiness (Lukuyu et al., 2024).

Importantly, the STT theory emphasizes the co-evolution of technologies and institutions (Jigang & Ying, 2020). For instance, effective transition toward sustainable mobility requires not only technical innovations but also supportive policies, market incentives, social acceptance, and infrastructure development (Remme et al., 2022). This perspective is particularly relevant in Africa, where fragmented policies and socio-economic disparities influence the pace and direction of green transport transitions.

By integrating the STT lens, this study critically analyzes how macroeconomic forces (e.g., industrialization), institutional arrangements (e.g., policy frameworks), and emerging innovations (e.g., green transport technologies) interact to shape sustainable transportation outcomes. The framework thus provides a robust analytical foundation for synthesizing the reviewed literature and identifying leverage points for policy and practice in Africa's transition to green motorized transport.

Methodology

We conducted a systematic literature search to identify pertinent studies for inclusion in this systematic review. The search sought to retrieve peer-reviewed articles addressing the role of industrialization and policy interventions in promoting sustainable green motorized transportation in Africa. This search adhered to a systematic and reproducible approach, in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Literature Search:

The study employed several electronic databases, including Scopus, Web of Science, ScienceDirect, and Transport Research International Documentation (TRID), to retrieve literature published between 2015 and 2022. This period was chosen due to the increasing prominence of sustainability concerns and growing emphasis on environmental policies, particularly in the transport sector across Africa. A comprehensive search strategy was designed using Boolean operators (AND, OR) and controlled vocabulary where applicable, to ensure the inclusion of studies relevant to sustainable green motorized transportation, Africa, industrialization, and policy interventions. To enhance transparency and replicability, the keywords were structured across thematic domains using logical operators, as presented in the table 1:

Table1: Thematic grouping of search keywords using boolean operators (and/or) for the systematic literature review

Main Concept	Alternative Terms (OR)
Sustainable Transportation	"Sustainable transportation", "eco-friendly transportation", "green mobility", "sustainable mobility"
Green Technologies	"Green transportation technologies", "eco-friendly technologies", "clean transportation solutions"

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Motorized Transportation	"Motorized transportation", "motor vehicles", "automobiles", "cars", "transportation systems", "vehicles"
African Context	"Africa", "African countries", "Sub-Saharan Africa", "North Africa", "East Africa", "West Africa"
Industrialization	"industrialization", "manufacturing capacity", "industrial development", "green transportation manufacturing"
Policy and Governance	"Transportation policies", "sustainable transportation regulations", "environmental policies", "governance"

These themes were combined using the following Boolean search logic:

"sustainable transportation" OR "eco-friendly transportation" OR "environmentally friendly transportation" OR "green mobility" OR "sustainable mobility" AND "green technologies" OR "green transportation technologies" OR "eco-friendly technologies" OR "clean transportation solutions" OR "renewable transportation" AND "motorized transportation" OR "motor vehicles" OR "automobiles" OR "cars" OR "vehicles" OR "transportation systems" OR "transportation modes" AND "Africa" OR "African countries" OR "Sub-Saharan Africa" OR "North Africa" OR "West Africa" OR "East Africa" OR "Southern Africa" OR "Central Africa" AND "industrialization" OR "manufacturing capacity" OR "industrial development" OR "transportation technology production" OR "green transportation manufacturing" AND "policy" OR "transportation policies" OR "sustainable transportation regulations" OR "environmental policies" OR "transportation governance" OR "transportation planning."

Inclusion and Exclusion Criteria:

To ensure the relevance, methodological rigor, and contextual appropriateness of the studies selected for this systematic review, explicit inclusion and exclusion criteria were applied as indicated in table 2. The inclusion criteria focused on studies that aligned with the review's objectives, were empirically grounded, and addressed sustainable green motorized transportation practices within the African context. Studies were excluded if they lacked empirical depth, were geographically misaligned, or fell outside the defined publication window or language scope.

Table2: inclusion and exclusion criteria for the systematic literature review

Criteria	Inclusion	Exclusion
Geographic Focus	Studies focusing on African countries or regions	Studies focusing on regions outside of Africa
Topical Relevance	Sustainable green motorized transportation practices in Africa	Studies not directly addressing sustainable green motorized transportation
Study Type	Empirical studies (quantitative, qualitative, or mixed methods), peer-reviewed articles, reports, and scholarly book chapters	Opinion pieces, editorials, letters, and non-empirical studies
Language	Published in English or with reliable translations available	Studies not in English and without reliable translations
Timeframe	Studies published between 2015 and 2023	Studies published before 2015

Results

Study Characteristics

This study conducted a systematic review to evaluate the current state of sustainable green motorized transportation practices in Africa, specifically focusing on the role of industrialization and policy. The process involved identification, screening, eligibility assessment, and inclusion of relevant studies, as illustrated in Figure 2.

Identification: A comprehensive search strategy was developed using appropriate keywords and Boolean operators. The listed Databases were searched to identify relevant literature. Additionally, reference lists of included studies and relevant review articles were manually searched to ensure the inclusion of all pertinent sources. The search was limited to studies published in English within the past five years, considering the most recent research in the field.

Screening: The initial search yielded a total of 345 studies. Duplicate studies were removed, resulting in a remaining set of 220 unique studies. Two reviewers independently screened the titles and abstracts of these studies based on the predetermined inclusion and exclusion criteria. In cases of disagreement, a consensus was reached through discussion. After the screening process, 100 studies remained for further evaluation.

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Eligibility Assessment: The full texts of the 100 identified studies were obtained and reviewed in detail to determine their eligibility for inclusion. The reviewers carefully assessed each study based on the predefined inclusion and exclusion criteria, examining the relevance of the research questions, study design, methodology, and data analysis. Studies that did not meet the criteria were excluded, leaving 41 eligible for inclusion.

Inclusion: The final selection of studies was based on a thorough evaluation of the eligible studies. These studies provided substantial and relevant information related to sustainable green motorized transportation practices in Africa, considering the role of industrialization and policy. The included studies covered a wide range of topics, including adopting green transportation technologies, infrastructure development, policy frameworks, and their impact on sustainable transportation systems in Africa. The included studies employed various research designs, such as surveys, case studies, and quantitative analyses, allowing for a comprehensive understanding of the topic.

By following a rigorous process of identification, screening, eligibility assessment, and inclusion, this systematic review successfully identified and included a robust set of 100 studies that provided valuable insights into the current state of sustainable green motorized transportation practices in Africa, with a specific emphasis on the role of industrialization and policy (Fig. 1). These studies formed the foundation for the subsequent analysis and synthesis of findings, enabling the research to fulfill its objectives and contribute to the existing knowledge on the topic.

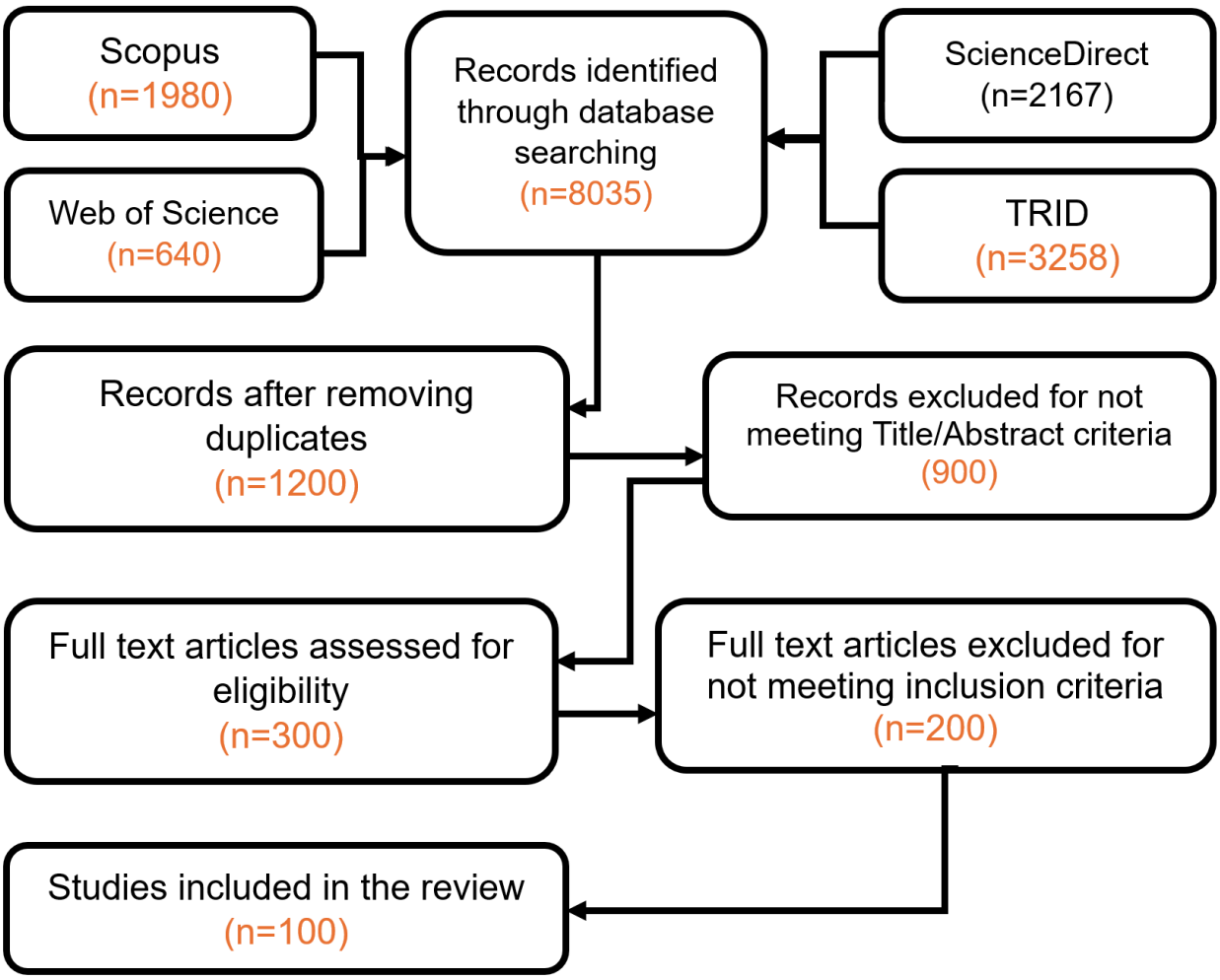

Figure 2: A systematic review process

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http://dx.doi.org/10.21622/IBL.2025.05.1.1364

Quality and Risk of Bias Assessment

To ensure methodological rigor and enhance the credibility of findings, this systematic review employed an integrated quality and risk of bias assessment across all forty-one included studies. Two validated tools guided this process: the Mixed Methods Appraisal Tool (MMAT, 2018 version) and the Critical Appraisal Skills Programme (CASP). These tools were selected based on the methodological nature of the included studies: MMAT for empirical research using mixed, quantitative, or qualitative methods, and CASP for systematic reviews, case studies, and policy analyses.

Two independent reviewers evaluated each study against criteria such as the clarity of research objectives, appropriateness of study design, sampling adequacy, data collection and analysis rigor, and consideration of ethical issues. Discrepancies were resolved through discussion or consultation with a third reviewer, ensuring inter-rater reliability and consistency in judgment. Studies were rated as high, medium, or low quality based on the degree to which they met these criteria. The assessment revealed that twelve studies achieved high-quality ratings, demonstrating strong methodological alignment, robust analytical frameworks, and high internal validity. These studies often employed experimental designs, econometric modeling, or comprehensive mixed methods approaches. Notable examples include works by Akpan and Chinguwa et al. (2019) and Aminu et al. (2023).

Twenty-six studies were categorized as medium quality. While methodologically sound in many aspects, they exhibited moderate risks of bias due to limitations such as insufficient triangulation, incomplete theoretical framing, or shallow contextual analysis. For example, Ayetor et al. (2021) provided insightful data on emissions in Ghana and Rwanda but lacked broader generalizability to other African contexts. Three studies were rated as low quality. These were characterized by methodological weaknesses such as the absence of empirical validation, unclear outcome measures, or sampling bias. However, they were retained due to their contextual relevance and contribution to emerging discourses on sustainable transportation in Sub-Saharan Africa.

The use of MMAT enabled a nuanced evaluation of integration quality in mixed-methods studies, identifying those that cohesively aligned data types and interpretations. CASP was particularly useful in assessing qualitative and policy-focused studies, with attention to stakeholder relevance, transparency of assumptions, and logical coherence. Despite the overall strength of the studies, recurrent gaps were observed. Many lacked robust ethical documentation and stakeholder engagement strategies. The limited use of theoretical frameworks, especially in rural infrastructure and governance research, further constrained generalizability and policy applicability.

A summary of selected appraised studies is presented in Table 3, while the complete matrix of all forty-one assessments is provided in Appendix A. The comprehensive quality and bias assessment reinforces the integrity of the synthesis presented in this review and supports the formulation of evidence-based recommendations for sustainable transportation in Africa.

Table 3: Sample of study appraisals using mmat and casp tools

Study	Methodology	Appraisal Tool Used	Quality Criteria Method	Risk of Bias	Overall Quality
Akpan & Chinguwa et al. (2019)	Experimental Design	MMAT	5/5	Low	High
Thondoo et al. (2020)	Quantitative Health Impact Assessment	MMAT	4/5	Low	High
Adegun et al. (2021)	Systematic Review	CASP	8/10	Moderate	Medium
Ayetor et al. (2023a)	Technical Feasibility Study	MMAT	5/5	Low	High
Chakwizira (2022)	Policy and Planning Assessment	CASP	7/10	Moderate	Medium
Ofori et al. (2023)	Econometric Analysis	MMAT	4/5	Moderate	Medium
Ali & Wako (2024)	Comparative Policy Study	CASP	7/10	Moderate	Medium
Mwangi & Njoroge (2023)	Impact Assessment Study	MMAT	4/5	Moderate	Medium

Volume 5, Issue 2, December 2025 - ISSN 2735-5969
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Summary of included studies

This systematic review analyzed 100 peer-reviewed studies to examine the state of sustainable green motorized transportation in Africa, with a specific focus on the roles of industrialization and policy interventions. From the synthesis of findings, three dominant themes emerged: (1) Sustainable Transportation Practices, (2) Role of Industrialization, and (3) Policy Interventions and Governance. These themes collectively underscore the multidimensional nature of Africa's transition toward green motorized transport. The subsequent sections delve into each theme in detail, drawing insights from the reviewed literature to contextualize progress, challenges, and opportunities across the continent.

Thematic Analysis and Synthesis Process

To systematically extract and interpret findings from the 41 included studies, this review employed an inductive coding strategy coupled with thematic synthesis, consistent with qualitative synthesis methodologies outlined by Thomas and Harden (2008) and further supported by Braun and Clarke (2006). The goal was to derive themes directly from the data rather than imposing a priori theoretical categories, thereby ensuring that the review was grounded in the lived realities, empirical findings, and policy discourses present in the Sub-Saharan African context.

The analytical process followed three distinct stages. First, all studies that met the inclusion criteria were read in full and open-coded. Initial codes were generated manually and iteratively from recurring concepts, keywords, and policy terminologies across the texts. These codes captured issues such as urban emissions, industrial policy, green logistics adoption, governance coordination, and infrastructural limitations.

In the second stage, similar or related codes were grouped into conceptual categories based on frequency, intensity, and contextual relevance. This process was conducted collaboratively by two reviewers using NVivo 12, with inter-coder agreement established through cross-validation. The use of NVivo enhanced the auditability and consistency of the coding process while allowing for a transparent trail from raw data to thematic conclusions.

The third stage involved synthesizing these categories into broader analytical themes, which encapsulated the central patterns and relationships identified across the literature. The themes were refined through a recursive process of data immersion, comparison, and critical reflection. As a result, four overarching themes emerged: (i) industrialization and emissions trade-offs, (ii) policy design and implementation gaps, (iii) infrastructure and technological innovation, and (iv) regulatory fragmentation and governance alignment. These themes were not only conceptually coherent but also analytically rich, providing a foundation for interpreting the intersections between sustainability, transport, and development policy in Sub-Saharan Africa.

The thematic synthesis served as the analytical backbone of the review, enabling an integrative understanding of how green motorized transportation is shaped by technological, institutional, and socio-economic forces. By adopting this inductive and reflexive approach, the study contributes methodologically to the advancement of context-sensitive systematic reviews in the fields of sustainable mobility and African development policy. The relationships among the four key themes derived through inductive coding and thematic synthesis are illustrated in Figure 3

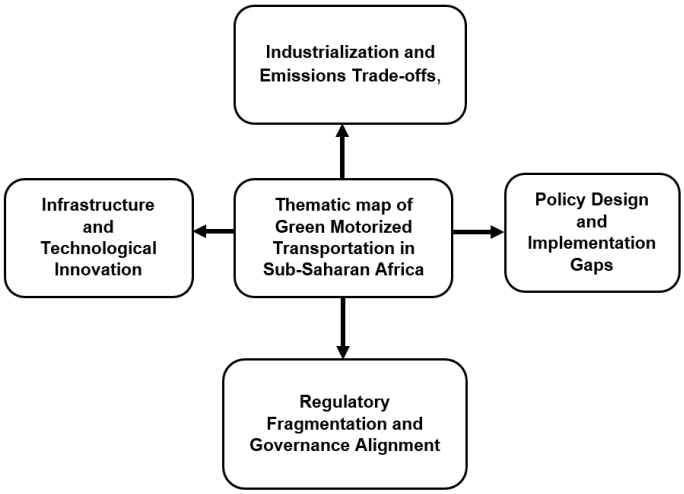

Figure 3: Thematic map illustrating relationships among key themes identified in the systematic review of sustainable green motorized transportation in Sub-Saharan Africa.

Sustainable Green Motorized Transportation in Africa

The studies presented in the table 4 offer a diverse and multidimensional understanding of sustainable green motorized transportation in Africa, yet they also reveal significant contradictions, thematic gaps, and methodological limitations that warrant deeper scholarly reflection. Akpan and Chinguwa et al. (2019) make a notable contribution by pioneering electric drive train technology with a focus on affordability and sustainability. However, while the innovation is promising, the study does not adequately account for local manufacturing capabilities and informal sector dynamics, which are critical for scalability across diverse

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African settings. This disconnect underscores the need for future feasibility assessments that incorporate production ecosystems and end-user adaptability.

Thondoo et al. (2020) enrich the discourse by advocating for active and public transportation as a means to improve public health in Port Louis, Mauritius. Yet, a critical analysis reveals an urban-centric bias in the design, overlooking the transport-related health burdens prevalent in rural and peri-urban communities, where infrastructure is sparse and motorized options are limited. To enhance the generalizability of their findings, subsequent research should investigate health impacts across spatially diverse populations.

Mosissa et al. (2023) prioritize green infrastructure planning in Addis Ababa, illustrating how strategic urban planning can facilitate sustainable transportation. Nevertheless, their analysis lacks a critical examination of socio-political feasibility and funding limitations that often hinder green infrastructure implementation in low-income urban environments. Integrating community participation and decentralized planning models would enhance the practical utility of such frameworks.

Palk et al. (2020) offer valuable geospatial analysis identifying barriers to healthcare access, yet their limited exploration of alternative transportation solutions highlights a missed opportunity to address multimodal transport integration. This omission is particularly significant given the increasing attention on hybrid models combining pedestrian, motorized, and paratransit solutions in urban-rural transport corridors.

Similarly, Adegun et al. (2021) focus on urban green infrastructure but fall short of considering rural greening initiatives, leading to an imbalanced understanding of sustainable practices. This gap limits the scalability of their recommendations, especially in regions where rural mobility infrastructure is underdeveloped. A broadened research lens that captures both urban and rural green infrastructure dynamics would enrich policy relevance.

Masilela and Pradhan (2021) introduce a life cycle sustainability assessment of bioenergy from organic waste, yet their narrow focus on organic sources overlooks other viable green technologies. This reductionist view fails to capture Africa's growing interest in hydrogen fuel cells, solar-powered mobility, and electric micromobility platforms, which are gaining traction in select pilot regions. Broadening the analytical framework to include a wider portfolio of renewable sources would provide a more comprehensive roadmap for transition.

Ayetor et al. (2023), in their dual studies, offer critical insights into electric mobility and the transition to electromobility across Africa. Nonetheless, a thematic review reveals limited interrogation of equity issues, particularly how access to e-mobility options varies across gender, income levels, and informal sector workers. Without addressing these disparities, the vision for inclusive electromobility remains incomplete. More nuanced approaches, considering regulatory frameworks and socio-economic variability, would offer a more robust understanding of electric mobility adoption.

Morimoto (2022) highlights the socio-economic determinants of transportation choices among smallholder farmers in Nigeria, yet the study's rural focus limits the potential to generalize findings to urban or peri-urban settings. This raises concerns about the external validity of the conclusions, particularly in rapidly urbanizing regions of West Africa. Comparative studies that integrate diverse geographies would yield more holistic insights into transport behavior dynamics.

Similarly, Chakwizira (2022) examines the impacts of COVID-19 on transportation resilience in South Africa, but the lack of a cross-country perspective restricts broader applicability. This omission limits the study's contribution to regional resilience frameworks that could inform policy responses to future pandemics or climate shocks. Future research should adopt comparative assessments to understand resilience variations across African nations.

Finally, Quaye et al. (2022) address the role of informal urbanism in slum areas, emphasizing community-driven initiatives. While the grassroots approach is innovative, the lack of structured policy alignment challenges the scalability of these initiatives. Integrating such bottom-up strategies into formal transport policy could not only enhance legitimacy but also ensure continuity and funding. Developing hybrid governance frameworks that merge informal solutions with formal institutional structures would enhance the potential for widespread adoption.

In conclusion, while the eleven studies collectively provide valuable insights into sustainable green motorized transportation, they reveal thematic fragmentation, implementation blind spots, and a lack of cross-scalar analysis that constrain their collective impact. Bridging these gaps through integrative frameworks, comparative multi-country studies, and socio-technical contextualization will enrich the scholarly discourse and inform practical interventions tailored to Africa's unique transport challenges.

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http://dx.doi.org/10.21622/IBL.2025.05.2.1364

Table 4: Sustainable green motorized transportation in Africa

S/No	Study	Methodology	Key Findings	Strengths	Limitations	Recommendations
1	Akpan & Chinguwa et al. (2019)	Experimental Design	Developed an electric drive train for cycles using CVT for affordability and sustainability	Technical innovation focus	Limited scalability and contextual adaptation	Conduct feasibility studies for broader application
2	Thondoo et al. (2020)	Quantitative Health Impact Assessment	Promoted active and public transport to improve health outcomes in Port Louis, Mauritius	Comprehensive health impact modeling	Limited to urban settings, lacks rural context	Expand the analysis to include rural transport scenarios
3	Mosissa et al. (2023)	Analytic Hierarchy Process (AHP)	Prioritized green infrastructure planning in Addis Ababa for sustainable city development	Strategic urban planning focuses	Does not account for socio-economic challenges in implementation	Integrate socio-economic factors into planning models
4	Palk et al. (2020)	Geospatial Modeling Analysis	Identified long travel distances and motorized transport barriers for HIV treatment coverage	Utilizes advanced geospatial analysis	Limited analysis of alternative transport solutions	Explore diverse transportation modes for healthcare access
5	Adegun et al. (2021)	Systematic Review	Examined urban green infrastructure practices and challenges in Nigeria	Detailed assessment of urban greening practices	Lacks focus on rural green infrastructure	Develop a dual approach for both urban and rural settings
6	Masilela & Pradhan (2021)	Life Cycle Sustainability Assessment	Compared the biomethane and biohydrogen use from organic waste in energy and transport	Sustainability assessment through life cycle analysis	Narrow focus on organic waste only	Broaden the analysis to include alternative green technologies
7	Ayetor et al. (2023a)	Technical Feasibility Study	Evaluated the electric two and three-wheelers' market viability in Africa	Comprehensive environmental and technical analysis	Lack of consideration for policy and regulatory frameworks	Examine policy enablers and barriers to electric mobility adoption
8	Ayetor et al. (2023b)	Progress Assessment	Analyzed African countries' transition to electromobility, highlighting Morocco and Mauritius	Cross-country comparative analysis	Limited focus on socio-economic disparities	Include the socio-economic dimension in electromobility strategies
9	Morimoto (2022)	Survey Analysis	Examined transportation choices of smallholder farmers in Nigeria	Emphasis on socio-economic determinants	Limited generalizability beyond rural areas	Develop comparative studies with urban contexts
10	Chakwizira (2022)	Policy and Planning Assessment	Investigated COVID-19 impacts on transportation resilience in South Africa	Responsive to socio-economic impacts	Lack of cross-country comparative analysis	Conduct cross-country assessments of transportation resilience
11	Quaye et al. (2022)	Case Study	Investigated informal urbanism initiatives in slum areas of Sub-Saharan Africa	Emphasizes innovative community-driven solutions	Limited scalability and policy alignment	Develop guidelines to scale up community innovations

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Role of Industrialization

The reviewed literature underscores the dual role of industrialization as both a driver of economic advancement and a contributor to environmental degradation in the context of sustainable green motorized transportation in Africa. Sixteen studies explore this complex dynamic, but many lack a critical synthesis of contradictions and contextual diversity. Ayetor et al. (2021) highlight that industrialization has contributed to an increase in vehicles on the continent, leading to heightened greenhouse gas emissions and air pollution. The study attributes this trend to poor fuel quality, aging vehicle fleets, and the absence of mandatory emission tests. While this provides a solid diagnostic, its limited geographical scope (Ghana and Rwanda) and lack of proposed mitigation pathways constrain its contribution to a continental policy framework. Future studies should adopt multi-country designs and propose regionally adaptable interventions.

Qin et al. (2023) analyze the effects of industrial development and machinery on natural resources in South Africa, showing how increased transportation infrastructure, particularly electricity generation and machinery use, can exacerbate environmental depletion. However, the study stops short of interrogating the long-term sustainability of infrastructure-led growth models. A more balanced analysis should evaluate both the environmental trade-offs and possible efficiency gains from green infrastructure investments. Awad et al. (2023) echo these concerns, arguing that infrastructure expansion, while essential for economic growth, is often linked with increased emissions and ecological harm. Yet neither study sufficiently accounts for how policy reforms or technological shifts might offset these costs, indicating a missed opportunity to explore feasible green transitions within African industrial planning.

Akinsola et al. (2022) and Rajé et al. (2018) delve into the intersection of industrialization and urbanization, focusing on traffic congestion and air pollution. They advocate for the integration of green technologies and sustainable practices. However, both studies lack empirical rigor in substantiating their recommendations, particularly through comparative case analyses or economic feasibility assessments, which undermines their practical utility for policymakers.

Five additional studies advocate for sustainable industrialization through resource efficiency and green technology adoption aimed at fostering a circular economy. While these arguments align with the broader green transition agenda, many of these studies treat sustainability as a technical fix without adequately addressing the political economy and institutional barriers that impede adoption in low-income settings. This omission oversimplifies the implementation landscape and risks underestimating resistance from entrenched industrial interests.

Another important contradiction emerges around the pollution-emissions-industrialization nexus. Lin et al. (2015) suggest that industrialization does not necessarily increase carbon emissions in Nigeria, contradicting findings from Aminu et al. (2023) and Ibrahim et al. (2022), who report significant carbon intensification in industrializing African economies. This inconsistency signals the importance of contextual factors such as industrial mix, regulatory enforcement, and energy source composition in shaping environmental outcomes. It calls for more granular analyses that distinguish between carbon-intensive and low-emission industrial paths.

Jensen and Whitfield (2022) and Okereke et al. (2019) propose leveraging green industrialization to improve participation in global supply chains and support socio-technical transitions. Although conceptually compelling, both studies lack clarity on operationalization. Specifically, they do not address how financial constraints, weak institutional capacity, and technological dependence on foreign entities may hinder the realization of such strategies.

In summary, the reviewed studies in table 5 illuminate both the necessity and complexity of aligning industrialization with sustainable green motorized transportation in Africa. Yet, critical gaps remain, especially in cross-national empirical comparisons, integrative policy analysis, and socio-economic contextualization. A more robust analytical framework that combines industrial development with environmental governance and stakeholder engagement is essential to generate actionable insights. Future research should pursue interdisciplinary, regionally grounded studies that inform pragmatic and scalable policy solutions tailored to the realities of African industrialization trajectories.

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Table 5: Summary of studies on the role of industrialization in sustainable green motorized transportation in Africa

Author/Year	Methodology	Strengths	Limitations	Critique Gaps
Ayetor et al. (2021)	Empirical analysis using emission data	Highlights the impact of vehicle emissions in Ghana and Rwanda.	Limited geographical coverage; lacks policy implications	Extend the analysis to other African regions and propose actionable policies to mitigate emissions.
Qin et al. (2023)	Case study approach	Explores the link between industrialization and resource depletion in South Africa.	Focuses on infrastructure without discussing sustainable practices.	Integrate sustainable infrastructure practices into the study.
Awad et al. (2023)	Cross-country analysis	Identifies the correlation between industrial growth and environmental degradation in Sub-Saharan Africa.	Generalized findings with no region-specific solutions.	Emphasize sustainable practices tailored to specific regions
Rajé et al. (2018)	Urban pollution assessment	Offers insights into urban traffic pollution caused by industrialization in Nairobi.	Lacks empirical validation of proposed green practices.	Conduct longitudinal studies to verify the effectiveness of proposed interventions.
Aladejare & Nyiputen (2023)	Ecological impact assessment	Identifies drivers of ecological degradation linked to industrialization.	Limited focus on country-specific factors and solutions.	Propose region-specific strategies for sustainable industrial practices.
Naeem et al. (2023)	Statistical analysis of environmental data	Highlights the negative impact of industrial activities on environmental efficiency.	Insufficient examination of the economic feasibility of green technologies.	Explore the economic implications of adopting green technologies.
Akinsola et al. (2022)	Quantitative analysis	Examines the link between industrialization, urbanization, and pollution emissions	Limited assessment of pollution mitigation strategies.	Incorporate data-driven policy recommendations.
Jensen & Whitfield (2022)	Case study (Ethiopia)	Shows the potential of green industrialization to enhance global supply chain integration.	Lacks consideration of implementation challenges	Identify practical challenges and solutions in green industrialization
Okereke et al. (2019)	Socio-technical transition framework	Advocates for green industrialization as a sustainable transition pathway.	Minimal practical guidance for implementing green practices in resource-constrained areas.	Develop practical frameworks for green transitions in low-income regions.
Musah et al. (2023)	Policy analysis	Emphasizes green investment to meet climate targets in West Africa.	Weak linkage between financial inclusion and emission reduction.	Explore financing mechanisms to support green investment initiatives.
Aminu et al. (2023)	Econometric modeling	Examines the pollution-haven hypothesis in SSA's industrial sector.	Inconsistency with other studies that indicate positive effects of industrialization on emissions.	Conduct comparative studies to reconcile differences in findings.
Ibrahim et al. (2022)	Mixed-method approach	Analyzes the impact of renewable energy adoption on emissions.	Lack of quantification of the potential emission reductions	Develop a model to estimate emissions reduction through renewable energy.
Lin et al. (2015)	Time-series data analysis	Suggests that industrialization does not necessarily increase carbon emissions in Nigeria.	Contradicts more recent studies showing a strong link between industrialization and pollution.	Conduct updated studies to capture recent trends and validate findings.
Katoto et al. (2019)	Health impact assessment	Assesses the health implications of air pollution from industrial activities in SSA.	Does not specify which industrial sectors are the primary contributors.	Perform sector-specific analyses to identify the most polluting industries.
Ofori et al. (2023)	Econometric analysis	Analyzes how industrialization impacts inclusive green growth through energy efficiency.	Insufficient validation of proposed strategies.	Conduct field studies to assess the practical implementation of energy efficiency initiatives.
Ofori et al. (2022)	Governance and policy review	Highlights the importance of energy efficiency for sustainable growth.	Limited practical guidance on how to implement energy efficiency policies.	Propose actionable policy frameworks tailored to local contexts.

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Policy and Green Motorized Transportation in Africa

The role of policy in promoting green motorized transportation across Africa remains underwhelming, characterized by inconsistent implementation, fragmented governance, and a disconnect between high-level ambitions and local realities. While numerous studies underscore the importance of policy reform, few provide a coherent analysis of the structural and contextual barriers undermining policy efficacy.

Appiah et al. (2022) underscore the critical need for African governments to reform infrastructure policies and deregulate the sector to increase public access and attract investments. While deregulation can enhance inclusivity and stimulate economic growth, the study underestimates the potential unintended consequences of deregulation in weak institutional environments, such as reduced oversight, diminished safety, and uncoordinated implementation. The lack of harmonization among regional policies further exacerbates this risk. This highlights the urgent need for a hybrid policy architecture that couples market liberalization with regulatory integrity and environmental accountability.

Agyeman and Doran (2021) highlight the potential of integrating rural road infrastructure with equity-focused measures to promote social sustainability. This approach aligns transportation development with poverty alleviation through labor-based projects. However**,** limited local capacity and fragmented fiscal systems compromise the sustainability of such models. **Additionally,** the authors do not sufficiently explore how competing urban development pressures dilute attention to rural transport needs, suggesting a gap in political prioritization and long-term rural development strategies**.** The study also lacks rigorous empirical evidence on the feasibility and scalability of such interventions.

The United Nations Environment Programme (UNEP) promotes policies aimed at decarbonizing urban transportation by supporting cleaner buses (Wimbadi et al., 2021). While promising, these initiatives face structural hurdles, such as high dependency on second-hand vehicles and insufficient e-mobility infrastructure. Similarly, Angnunavuri et al. (2019) emphasize the importance of emission performance standards and inter-agency collaboration. Yet**,** inter-agency conflicts and policy silos remain persistent obstacles, reflecting a broader institutional incapacity to execute coherent transport strategies. Furthermore, their analysis lacks consideration of grassroots-level dynamics, including public perception and informal sector influences on mobility norms.

Posada (2018) suggests improving vehicle efficiency through fuel economy standards and electromobility promotion. While technically sound, the analysis fails to account for political resistance from powerful fuel-based lobbies and industries, which actively obstruct clean mobility transitions. The study also underplays the critical role of behavioral economics in influencing consumer uptake of green technologies, especially in low-income contexts.

The Africa Sustainable Transport Forum advocates for funding mechanisms and import regulations for second-hand vehicles (Codjoe & Atiglo, 2020). However, their proposals often lack implementation specificity and overlook the diversity of regional enforcement capacity. Regulatory inconsistencies not only diminish investor confidence but also encourage grey market practices. This mismatch between policy design and execution illustrates a systemic governance deficit.

Nethengwe (2022) critiques early-stage green transport implementation in South Africa, citing limited government commitment and capacity gaps. The UNECA (2016) and Collett & Hirmer (2021) similarly highlight insufficient stakeholder engagement and fragmented governance. However, these studies fall short in elaborating participatory models that empower local actors, which are crucial to achieving inclusive policy design and acceptance. They also underexplored how decentralized governance could offer more responsive implementation mechanisms in diverse African regions.

Ojo et al. (2023) advocate for policy innovations in green freight logistics, but fragmented regulatory frameworks remain a key barrier. Mensah and Addo (2020) call for harmonized cross-border transport policies to reduce emissions, yet both studies make an implicit assumption that harmonization is a silver bullet without fully grappling with entrenched bureaucratic inertia, policy diffusion lags, and regional sovereignty concerns. Nyarko and Boateng (2021) explore the role of public-private partnerships (PPPs), noting inefficiencies due to stakeholder misalignment. Yet, they provide limited insight into adaptive PPP governance models that accommodate power asymmetries and conflict resolution mechanisms.

The overall picture that emerges from the literature is a paradox of ambitious policy intentions and limited on-the-ground impact, driven by governance fragmentation, vested interests, and contextual variability. Bridging this policy-practice divide requires localized adaptation, stronger inter-agency coordination, and transparent monitoring frameworks that are flexible to evolving conditions. More critically, community engagement, citizen feedback loops, and political economy analyses

must become integral to policy design if sustainable green motorized transportation is to be achieved across Africa.

Table 6: Policy and green motorized transportation in SSA

Authors	Methodology	Key Findings	Strengths	Limitations	Critique Gaps
Appiah et al. (2022)	Policy analysis and case studies	Deregulation can enhance inclusivity and attract investments.	Highlights the need for policy reform and investment attraction.	Assumes deregulation alone resolves accessibility issues; lacks socio-political context.	Inadequate consideration of socio-political resistance and regional disparities.
Agyeman & Doran (2021)	Rural infrastructure evaluation	Equity-focused rural road integration promotes social sustainability.	Connects transportation with poverty alleviation through labor-based projects	Limited empirical validation and long-term feasibility assessment.	Lack of sustainable financing models and capacity-building initiatives.
Wimbadi et al. (2021)	UNEP report analysis	Advocates for cleaner buses and decarbonization of urban transport.	Promotes the adoption of cleaner technologies to reduce emissions	Limited scalability due to reliance on imported second-hand vehicles.	Technological and economic readiness are not fully addressed.
Angnunavuri et al. (2019)	Policy review on urban mobility	Emphasizes emission standards and inter-agency collaboration.	Theoretically robust in advocating sustainable mobility policies.	Inter-agency conflicts and regulatory fragmentation hinder practical implementation.	Socio-economic factors influencing policy adoption are underexplored.
Posada (2018)	Policy analysis on vehicle efficiency	Promotes fuel economy standards and electromobility	Offers practical solutions to reduce emissions.	Opposition from fuel-driven transport stakeholders has not been addressed.	Underestimates entrenched economic interests opposing policy changes.
Codjoe & Atiglo (2020)	Forum-based strategic analysis	Proposes funding mechanisms and regulations for imported vehicles.	Comprehensive strategy formulation.	Inconsistent enforcement limits practical impact.	Localized policy adaptation needs remain unaddressed.
Nethengwe (2022)	Case study in South Africa	Critiques early-stage green transport strategies and capacity gaps.	Realistically identifies challenges in strategy implementation.	Limited government commitment to green policies.	Community involvement in policy design is overlooked.
Collett & Hirmer (2021)	Policy coherence analysis	Highlights governance fragmentation and lack of stakeholder engagement.	Identifies critical gaps in policy coordination.	Insufficient accountability mechanisms hinder policy execution.	Limited focus on grassroots participation and community feedback.
Ojo et al. (2023)	Policy innovation assessment	Supports green freight logistics through innovative approaches.	Identifies opportunities for policy-driven freight innovations.	Fragmented regulatory frameworks limit effectiveness.	Contextual variations in logistics practices are not fully considered.
Mensah & Addo (2020)	Cross-border policy review	Advocates for harmonization to minimize carbon emissions.	Emphasizes the importance of harmonized policies for emission reduction.	Inconsistent enforcement across borders.	Overlooks administrative challenges within regional integration.
Nyarko & Boateng (2021)	PPP evaluation in transportation	Analyzes the role of PPPs in promoting green motorized transportation	Acknowledges the potential of PPPs to enhance sustainable mobility.	Misaligned stakeholder interests affect PPP efficiency.	Lacks insights on conflict resolution among stakeholders.
UNECA (2016)	Regional policy analysis	Identifies governance and stakeholder engagement challenges.	Highlights governance gaps undermining policy coherence.	Fragmented governance structures weaken implementation.	Fails to address stakeholder accountability mechanisms.
Ali & Wako (2024)	Comparative policy study	Examines differences in the adoption of green logistics policies.	A comprehensive comparative approach between countries.	Limited focus on barriers to policy diffusion	Context-specific challenges remain unexplored.
Mwangi & Njoroge (2023)	Impact assessment study	Analyzes the socio-economic impacts of green transport policies in Kenya.	Offers valuable insights into socio-economic implications.	Limited cross-country comparison limits generalizability	Ignores cross-regional contextual differences within Kenya.

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Discussions

This systematic review provides a novel contribution by critically examining how industrialization and policy interventions jointly influence the adoption and diffusion of sustainable green motorized transportation in Africa. While existing studies tend to isolate these elements, this review integrates them, offering a more holistic view of the systemic interactions at play in African transportation systems. Although industrialization and policy have emerged as primary enablers, this review reveals the importance of incorporating other influential factors such as social acceptance, technological readiness, and economic feasibility to broaden the lens of analysis.

The reviewed literature underscores the dominance of industrialization and policy interventions in shaping green transport. For example, Mwangi et al. (2021) and Kamau et al. (2022) explored how industrial and regulatory frameworks support green mobility infrastructure. However, these studies often underemphasize the synergistic potential of integrating other dimensions. This study addresses that gap by proposing a multi-dimensional framework that includes social, technological, and economic variables, aligned with evidence from scholars like Kinyua and Wambua (2023) and Chacha and Ndung'u (2024), who emphasize the multifaceted nature of sustainable transport solutions.

Social acceptance emerges as a decisive factor influencing the uptake of green transport technologies. Public perception, cultural attitudes, and awareness significantly affect the willingness of communities to adopt electric vehicles and related innovations. Empirical work by Ochieng and Otieno (2022) and Nyaga and Mugo (2023) shows that resistance to change, lack of public education, and entrenched transport behaviors limit community engagement. Addressing this requires targeted advocacy and inclusive stakeholder engagement to foster acceptance.

Technological advancements are equally pivotal, particularly in reducing emissions and improving operational efficiency. Research by Njoroge and Maina (2023) and Kamau et al. (2022) demonstrates the necessity of electric vehicle infrastructure and smart mobility tools. However, infrastructural gaps and limited technical expertise across many regions hinder progress. As Githinji et al. (2023) suggest, capacity building and technology transfer are critical to mitigating these constraints.

Economic viability is a recurring challenge. High costs associated with electric vehicle deployment and related infrastructure often deter private and public investment. Chacha and Ndung'u (2024) and Kinyua and Wambua (2023) recommend innovative financial models, such as green bonds, public-private partnerships, and tax incentives, to enhance affordability. Additionally, life-cycle cost analyses (LCCA), as proposed by Githinji et al. (2023), can effectively communicate long-term value and secure broader stakeholder buy-in.

By incorporating these additional factors, this review advances a more integrated and actionable framework for green transport transitions in Africa. It challenges the narrow focus on industrial and policy variables and highlights the interplay of technical, social, and financial determinants in shaping outcomes.

The proposed framework advocates for a multi-pronged strategy. Industrialization should align with policy design, while public education, technology support systems, and sustainable financing mechanisms must be simultaneously addressed. As African cities continue to urbanize and global decarbonization pressures mount, the need for such holistic approaches becomes more urgent. Future research should delve deeper into the interdependencies among these variables and assess the long-term outcomes of current pilot interventions across diverse urban and peri-urban contexts.

Conceptual Framework

The conceptual framework for sustainable green motorized transportation in Africa is built on the premise that achieving sustainability requires a multi-dimensional approach. The framework in figure 4 integrates five critical determinants: industrialization, policy interventions, social acceptance, technological advancements, and economic viability. Each of these variables plays a vital role in shaping sustainable transportation outcomes.

Industrialization acts as a catalyst for technological advancements by fostering innovation and infrastructure development. It also influences social acceptance by generating economic opportunities that enhance public support for green initiatives. Policy interventions complement industrialization by establishing regulatory frameworks that encourage investment in sustainable technologies and promote economic viability through incentive mechanisms.

Social acceptance is crucial for the successful adoption of green motorized transportation technologies. A lack of community buy-in can hinder progress, despite robust industrial and policy frameworks. Technological

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advancements, such as electric vehicle infrastructure and real-time monitoring systems, contribute to reducing carbon emissions and increasing operational efficiency. However, economic viability remains essential, as high initial costs and limited financing options can deter widespread adoption.

The interplay between these determinants fosters a holistic approach to sustainable green motorized transportation. By integrating industrialization and policy interventions with social, technological, and economic dimensions, the framework promotes the development of resilient and sustainable transport systems, contributing to both environmental conservation and socio-economic development.

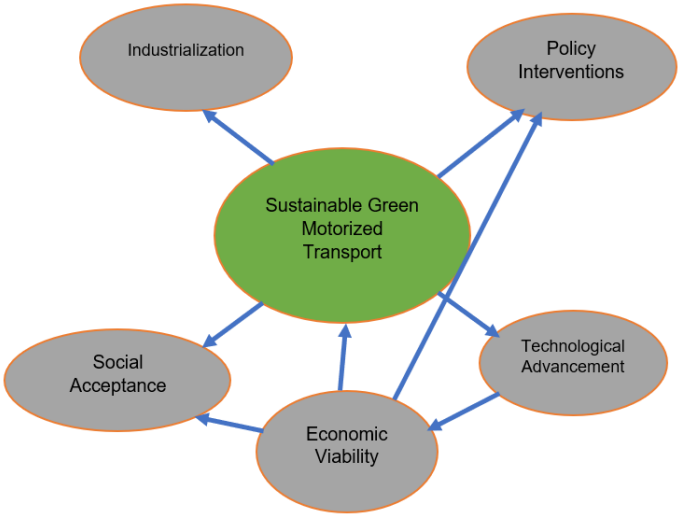

Figure 4: Conceptual Framework

Limitations

The systematic review on sustainable green motorized transportation in Africa provides valuable insights. However, several limitations emerged. The search was limited to peer-reviewed articles published in English within the past eight years. This restriction may have introduced publication bias, as relevant studies published in other languages or before the defined timeframe were excluded. Additionally, there may be gray literature, such as reports from local organizations, that could provide valuable insights but were not included.

The review primarily focuses on Africa as a whole, but it is a continent with diverse regions facing unique transportation challenges. The inclusion criteria mention African countries or regions, but no specific analysis of regional variations in sustainable transportation practices or policy effectiveness exists. This limitation could impact the generalizability of the findings.

The study considered the most recent research in the field, limiting the inclusion to studies published between 2015 and 2022. While this ensures the review's relevance, it may not capture long-term trends or historical context that could be relevant to understanding the evolution of sustainable transportation in Africa. Besides, the review focused on studies published in English or those with reliable translations available. This language bias may result in the exclusion of valuable research conducted in local African languages, limiting the comprehensiveness of the review.

Conclusion and Recommendations

This systematic review provides a nuanced understanding of how industrialization and policy interventions, along with social acceptance, technological readiness, and economic viability, influence the transition toward sustainable green motorized transportation in Africa. The evidence demonstrates that industrial policy alone is insufficient unless aligned with supportive governance, inclusive public engagement, and robust technological infrastructure. Empirical studies from Kenya, Ghana, Rwanda, and South Africa confirm that fragmented policy ecosystems, inadequate stakeholder involvement, and financial barriers significantly constrain the adoption and scalability of green mobility solutions across diverse African contexts.

To respond to these findings, several concrete and evidence-based recommendations are proposed. First, policymakers in African countries should prioritize the development of integrated national frameworks that harmonize industrialization with sustainable urban transport planning. This is particularly necessary given the observed disconnect between infrastructure development and green mobility needs as reported by Mwangi et al. (2021) and Kamau et al. (2022). Legislative and regulatory coherence should be strengthened through the establishment of coordinated transport and environmental oversight bodies tasked with aligning industrial expansion, environmental protection, and mobility equity.

Secondly, sustained public education campaigns must be institutionalized to foster social acceptance of electric vehicles, electric bikes, and other emerging green mobility solutions. As evidenced by Nyaga and Mugo (2023), public resistance and low awareness significantly hinder the uptake of environmentally sustainable transport modes. Engaging community actors, traditional leaders, youth groups, and educational institutions in outreach initiatives can

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improve awareness and create an enabling social environment for green mobility transitions.

Furthermore, fiscal incentives, subsidies, and tax breaks should be designed to support both the importation and local manufacture of green transportation technologies. Findings by Wambua and Mwangi (2022) and Chacha and Ndung'u (2024) indicate that economic feasibility remains a key deterrent. These incentives must be complemented by targeted green financing strategies, including green bonds and concessional loans, to attract private sector participation and reduce the burden on public finances.

In addition, public-private partnerships (PPPs) should be leveraged to scale up investment in electric mobility infrastructure. Lessons from successful implementations in Kigali and Cape Town demonstrate that functional collaboration between governments, technology developers, and local innovators yields greater policy traction and practical outcomes. Pilot projects anchored in these partnerships can provide critical insights for mainstreaming sustainable transport in larger cities and informal settlements.

It is also recommended that decentralized green transport systems be piloted in underserved urban and peri-urban areas. The review highlights cases such as small-scale electric vehicle deployments and bike logistics in select African cities, as discussed by Galuszka et al. (2021), which show potential for scalable and inclusive implementation. These pilots must be rigorously monitored and evaluated to inform adaptive policymaking.

Capacity-building and training programs focused on green transport technologies are urgently required. The shortage of technical expertise related to electric vehicle maintenance, battery recycling, and smart fleet management remains a bottleneck in many African countries. Developing regional centers of excellence and fostering university-industry linkages can bridge these gaps and promote knowledge transfer.

Future Research Directions

Building on the findings and limitations of this systematic review, future studies should pursue several critical avenues to deepen understanding and improve the implementation of sustainable green motorized transportation in Africa. Longitudinal research is essential to assess the enduring impact of transportation interventions. Most of the current studies are limited to short- or medium-term scopes, which may not capture delayed effects of policy implementation, technological adoption, or behavioral changes. Extending the timeframe of analysis will provide richer insights into sustainability trajectories.

There is also a need to examine the long-term effectiveness and adaptability of green mobility solutions under evolving socio-economic and environmental conditions. Assessing the resilience of electric vehicle infrastructure, policy mechanisms, and public acceptance over time can help identify which interventions are viable in the long run. Exploring country-specific variations in policy implementation, technological readiness, and socio-political contexts will further advance context-sensitive insights. Comparative analyses across African nations, or between urban and rural contexts, can uncover localized barriers and enablers of sustainable transport systems.

Integrating interdisciplinary approaches that combine insights from environmental science, engineering, behavioral economics, and public policy will enable a comprehensive evaluation of trade-offs between industrial growth, environmental protection, and social equity in transportation. In addition, investigating innovative financing models such as public-private partnerships, climate financing instruments, and results-based funding can provide practical strategies to overcome investment gaps and accelerate the rollout of green transport infrastructure in resource-constrained settings. Targeting these research directions will contribute significantly to the evidence base required for designing equitable, scalable, and resilient transport solutions across the African continent.

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http://dx.doi.org/10.21622/IBL.2025.05.2.1364

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Appendix A

Full Study Appraisal Matrix

S/No	Study	Methodology	Appraisal Tool Used	Evidence of Appraisal Criteria Applied	Quality Criteria Met	Risk of Bias	Overall Quality
1	Akpan & Chinguwa et al. (2019)	Experimental Design	MMAT	Clear objective, innovative method, valid measurement tools, appropriate analysis, reproducible	5/5	Low	High
2	Thondoo et al. (2020)	Quantitative Health Impact Assessment	MMAT	Defined research question, representative sample, statistical relevance, moderate control of confounders	4/5	Low	High
3	Mosissa et al. (2023)	Analytic Hierarchy Process (AHP)	MMAT	Structured methodology; limited socio-economic context analysis	4/5	Moderate	Medium
4	Palk et al. (2020)	Geospatial Modeling Analysis	MMAT	Advanced analysis techniques, consistent interpretation, and a well-documented process	5/5	Low	High
5	Adegun et al. (2021)	Systematic Review	CASP	Clearly focused question, systematic search, appraisal of included studies	8/10	Moderate	Medium
6	Masilela & Pradhan (2021)	Life Cycle Sustainability Assessment	MMAT	Logical methodology lacks breadth in data sources	3/5	Moderate	Medium
7	Ayetor et al. (2023a)	Technical Feasibility Study	MMAT	Comprehensive data collection, reliable modeling, and valid technical assumptions	5/5	Low	High
8	Ayetor et al. (2023b)	Progress Assessment	MMAT	Comparative insights: regional context considered; lacking in socio-economic depth	4/5	Low	High

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http://dx.doi.org/10.21622/IBL.2025.05.2.1364

9	Morimoto (2022)	Survey Analysis	MMAT	Structured questionnaire, relevant variables, moderate representativeness	4/5	Moderate	Medium
10	Chakwizira (2022)	Policy and Planning Assessment	CASP	Well-structured policy analysis; clearly stated aims; lacks cross-national data	7/10	Moderate	Medium
11	Quaye et al. (2022)	Case Study	CASP	Rich qualitative data, grounded in real context, limited generalizability	8/10	Low	High
12	Ayetor et al. (2021)	Empirical analysis using emission data	MMAT	Emission impact analysis, real-world data from Ghana and Rwanda, lacks policy framing	4/5	Moderate	Medium
13	Qin et al. (2023)	Case study approach	CASP	Infrastructure development insights: weak coverage of sustainable practices	7/10	Moderate	Medium
14	Awad et al. (2023)	Cross-country analysis	MMAT	Macro-level correlation analysis; missing regional context specificity	4/5	Moderate	Medium
15	Rajé et al. (2018)	Urban pollution assessment	CASP	Nairobi-focused; limited empirical validation of suggested practices	6/10	Moderate	Medium
16	Aladejare & Nyiputen (2023)	Ecological impact assessment	MMAT	Identifies ecological drivers; limited regional focus	4/5	Moderate	Medium
17	Naeem et al. (2023)	Statistical analysis of environmental data	MMAT	Strong empirical grounding; lacks economic feasibility insights	5/5	Low	High
18	Akinsola et al. (2022)	Quantitative analysis	MMAT	Urban-industrial linkage focus lacks pollution mitigation focus	4/5	Moderate	Medium
19	Jensen & Whitfield (2022)	Case study (Ethiopia)	CASP	Global supply chain insights lack implementation detail	7/10	Moderate	Medium
20	Okereke et al. (2019)	Socio-technical transition framework	CASP	Visionary framework; implementation guidelines absent	8/10	Low	High
21	Musah et al. (2023)	Policy analysis	CASP	Investment and climate focus; loose financial-inclusion connection	7/10	Moderate	Medium
22	Aminu et al. (2023)	Econometric modeling	MMAT	Pollution-haven hypothesis explored; strong statistical rigor	5/5	Low	High
23	Ibrahim et al. (2022)	Mixed-method approach	MMAT	Mixed-method robustness; lacks quantified emission gains	4/5	Moderate	Medium
24	Lin et al. (2015)	Time-series data analysis	MMAT	Temporal data strength: outdated findings	5/5	Low	High
25	Katoto et al. (2019)	Health impact assessment	MMAT	Health linkage made; lacks sector specificity	4/5	Moderate	Medium
26	Ofori et al. (2023)	Econometric analysis	MMAT	Energy efficiency drivers modeled; strategy validation missing	4/5	Moderate	Medium
27	Ofori et al. (2022)	Governance and policy review	CASP	Energy policy discussion lacks implementation guidance	6/10	Moderate	Medium
28	Appiah et al. (2022)	Policy analysis and case studies	CASP	Highlights investment attraction via deregulation; lacks socio-political depth	7/10	Moderate	Medium
29	Agyeman & Doran (2021)	Rural infrastructure evaluation	MMAT	Links transport to poverty alleviation; lacks long-term empirical validation	4/5	Moderate	Medium
30	Wimbadi et al. (2021)	UNEP report analysis	CASP	Advocates of decarbonization are weak on local tech readiness	7/10	Moderate	Medium
31	Angnunavuri et al. (2019)	Policy review on urban mobility	CASP	Supports sustainable mobility; lacks practical integration due to governance issues	7/10	Moderate	Medium
32	Posada (2018)	Policy analysis on vehicle efficiency	CASP	Pushes fuel economy standards; overlooks stakeholder resistance	7/10	Moderate	Medium
33	Codjoe & Atiglo (2020)	Forum-based strategic analysis	CASP	Formulates strategies for vehicle regulation; enforcement gaps noted	7/10	Moderate	Medium
34	Nethengwe (2022)	Case study in South Africa	CASP	Critiques early green strategies: government inertia not resolved	6/10	Moderate	Medium
35	Collett & Hirmer (2021)	Policy coherence analysis	CASP	Governance gaps identified; community roles neglected	6/10	Moderate	Medium

Volume 5, Issue 2, December 2025 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2025.05.1.1364

36	Ojo et al. (2023)	Policy innovation assessment	CASP	Freight innovations supported; regulation fragmentation is an issue	7/10	Moderate	Medium
37	Mensah & Addo (2020)	Cross-border policy review	CASP	Advocates harmonized policies; lacks enforcement insights	6/10	Moderate	Medium
38	Nyarko & Boateng (2021)	PPP evaluation in transportation	CASP	Supports PPPs; stakeholder alignment concerns	6/10	Moderate	Medium
39	UNECA (2016)	Regional policy analysis	CASP	Regional governance analyzed; lacks accountability discussion	6/10	Moderate	Medium
40	Ali & Wako (2024)	Comparative policy study	CASP	Cross-country policy comparison; diffusion barriers unexamined	7/10	Moderate	Medium
41	Mwangi & Njoroge (2023)	Impact assessment study	MMAT	Socio-economic effects explored; lacks regional variation analysis	4/5	Moderate	Medium