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Technology-Driven Sustainability in Developing Countries: A Bibliometric Analysis

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Abstract. To seek sustainable development worldwide, developing countries are confronted with the double challenge of pursuing economic growth and, at the same time, addressing pressing environmental and social problems, which present an urgent need for technology-based solutions. The study aims to visualize the intellectual and conceptual structure of technology and sustainability-related research in developing countries, to recognize its core themes and intellectual pathscaping. The study uses a bibliometric approach; co-citation and co-occurrence analyses were applied to a corpus of peer-reviewed journal articles from the Scopus database as of 2021. The findings indicate a field whose intellectual center does not feature foundational sustainability theories, but is surprisingly colonized by advanced econometric methodology papers, particularly panel data analysis. From a quantitative perspective, thematic analysis mainly revolves around significant issues (energy transitions, resource management, and the circular economy). The discussion and conclusion identify a key tension in the field. On one hand, the field's empirical and methodological rigor ensures it generates robust, policy-relevant evidence. However, it potentially marginalizes the rich theoretical and qualitative perspectives on which a more complete understanding depends. This study suggests that the research landscape is methodologically advanced but theoretically limited, suggesting a significant imperative to combine diverse research traditions better to drive sustainable development theory and practice in the developing world.

Keywords: *Technology-driven sustainability; Renewable energy; Circular economy; Green innovation; Developing countries*

1.0 Introduction

As the world seeks sustainable development, developing countries are at a crossroads, challenged with the demand for rapid economic growth and the need to confront environmental and social concerns. Technology-based sustainable development has evolved as a potent paradigm for providing new opportunities for these countries to liberate growth from resource exhaustion and ecological decay (Hammami et al., 2025). Most emerging economies can create more resilient, inclusive, and environmentally friendly societies using progress in digital and green technologies. This is not to accept the tools alone, but to reimagine development models consistent with sustainability, stipulating that the welfare of future generations matters, as Hariram et al. (2023).

The development-enhancing role technology could play in developing countries is vast. Where developed nations are taking the burden of legacy infrastructure, many developing nations do not carry the same chains. They can jump straight to more advanced, more sustainable technology. For example, advancements in mobile technology are transforming access to financial services, education, and healthcare in some of the most marginalized areas, driving economic inclusion and empowerment (Basnayake et al., 1024). Also, decentralized renewable energy, such as solar mini-grids, provides clean and affordable power to millions of people for the first time, leading to decreased dependence on fossil fuels and reduced impacts on climate change (Ukoba et al, 2024). Precision farming mechanisms and data analytics support small-holder farmers to increase their yields, save water, and withstand the pressures of climate change (Aijaz et al., 2025) (see agriculture also).

However, the road to tech-based sustainability is not all clear. Substantial obstacles, such as high capital costs, a lack of infrastructure, and a sustained digital divide, can impede the broad market acceptance of green technologies. In addition, a lack of technical know-how, poor regulations, and policy support can hinder the efficacy of innovation and technological interventions. Addressing these challenges calls for a shared effort by governments, the private sector, and the international community to create an enabling environment conducive to investment, capacity building, and the broader sharing of technology dividends with all parts of society.

Given the present global development scenario, the theme of technology-driven sustainability, especially from a developing country perspective, has become increasingly significant. This is especially critical in regions facing widespread environmental problems and socioeconomic inequality, where understanding how technology can encourage sustainable behaviour is crucial. Bibliometric analysis provides a rigorous means of reviewing scientific literature, offering insights into the structuring and development of knowledge within a field.

Although a growing body of literature applies bibliometric methods for sustainability research, a research gap remains. More specifically, to the best of our knowledge, no bibliometric review existed to date that not only reviews the intellectual and conceptual structure of technology-driven research while focusing only on the developing countries' context in sustainability. Existing analyses tend to be global and thus cannot account for these countries' context-specific challenges, priorities, and research agendas. This gap must be addressed to inform policymakers and practitioners and enhance the ability to devise operational, context-specific approaches.

This study attempts to address this dearth in the literature by offering an in-depth and targeted review of the field. Using co-citation and co-occurrence analyses, it documents the most cited literature, primary themes, and emerging topics that have significantly formed the literature related to the technology-based sustainability perspectives on developing countries. The results are designed to contribute to research and application knowledge, enhancing our understanding of how technology can address sustainability challenges and inform organizations with practical implications. Through analytical work that characterizes the intellectual base and theoretical development of one such area, this paper provides the groundwork for innovation in environmentally sustainable development interventions that are now badly needed.

The paper is organized to lead readers through this research: Section 2 reviews the previous literature on technology-oriented sustainability and bibliometric technology to clarify the background. Section 3 describes the methodology, which covers the search strategy, data collection, and analysis process. Section 4 analyzes the co-citation and co-occurrence of the papers and discusses the main results and emerging themes. Section 5 concludes by drawing implications of the findings of this study and recommending policy and organizational practices for future research and practitioners. Section 6 concludes the paper by discussing the main findings and highlighting the study's contributions to technology-driven sustainability in development.

2.0 Methodology

2.1 Research Design

The Scopus search of the database was performed on March 20, 2025, with a search string applied against the "topic" field (which contains the title, abstract, and keywords). Scopus is one of the largest academic databases and contains more than 89 million records in science, technology, medicine, social sciences, and humanities (Elsevier, 2024). It now covers over 28,100 peer-reviewed journals and is one of the most popular databases for bibliometric analyses (Scopus, 2024). Scopus has been widely applied for bibliometric analysis given the wide range of disciplines covered, citation data structure, and high-impact journal indexing (Donthu et al., 2021; Fahimnia et al., 2015). Compared to other databases, Scopus is recognized for its comprehensive citation coverage and analysis, thus ensuring a good-quality dataset for bibliometric research (Zupic & Čater, 2015). As for exclusion criteria, the research restricts the time frame to include publications through 2021 to maintain trend consistency. Furthermore, only papers that appeared in a journal are considered, whereas conference papers, books, and book chapters are not considered. This specific criterion is designed to facilitate the selection of published research of a high standard, peer-reviewed research that has survived the scrutiny of tough-to-please editors like those of Scopus (Mingers & Leydesdorff, 2015). By limiting Scopus only, this paper guarantees data reliability and integrity, and can further draw a complementary picture in technology-driving sustainable research in emerging countries.

2.2 Search Strategy and Data Collection

The information for the current study was collected from the Scopus database, which is considered one of the most comprehensive resources in the world of peer-reviewed publications across technology, science, social science, and cognitive sciences—search date 20 March 2025. The search string was developed systematically, based on keywords such as "technological innovation", "sustainability", and "emerging countries". These themes were then combined with Boolean operators into a search query focused on the intersection of technology and sustainability at the level of emerging countries. Specific inclusion and exclusion criteria are applied in this study to maintain the quality and strength of the dataset.

The review deliberately restricts itself to studies until the end of 2021. This time frame was selected to establish a stable foundation for the entire knowledge area at the required level, in response to the significant changes and acceleration in digital transformation and sustainability research that occurred post-2019, directly related to the pandemic. This approach enables an in-depth analysis of a full-grown and mature data set, resulting in a map of the intellectual structure that can now be used as a reference for future comparative research.

The study is limited to articles and does not include conference proceedings, books, and book chapters. This choice favors including high-quality, rigorously peer-reviewed research that meets the high editorial criteria maintained in Scopus, a widely practiced methodology in bibliometric analysis to ensure data quality. While they acknowledge that this approach may have missed some important grey literature or classic texts, especially from a developing country setting, it does enable the data to be reliable and comparable.

3.0 Results and Discussion

Based on Figure 1, there is a clear upward trend in sustainability research across all top countries, particularly accelerating after 2015, which coincides with the adoption of the UN Sustainable Development Goals. China shows the most dramatic increase in sustainability publications, especially from 2017 onward. In recent years, China has become the leading producer of sustainability research among the countries analyzed, showing its increasing focus on environmental issues and green development. India shows a consistent upward trend, with a notable acceleration around 2018-2019, reflecting the country's growing emphasis on sustainable development and renewable energy. The US maintains a significant but more gradual increase in sustainability publications compared to the rapid growth seen in China and India. The data shows how different regions (represented by countries like Brazil, South Africa, and others in the stacked chart) contribute to the global sustainability research landscape, with varying growth rates. There appears to be some fluctuation in recent years, possibly reflecting the impact of global events like the COVID-19 pandemic on research priorities and publication rates. The parallel growth across multiple countries suggests an international recognition of sustainability as a critical research area, though with different emphases based on national priorities. These trends reflect the growing global importance of sustainability research and the shifting centers of academic production from traditionally dominant Western countries to emerging economies, particularly in Asia.

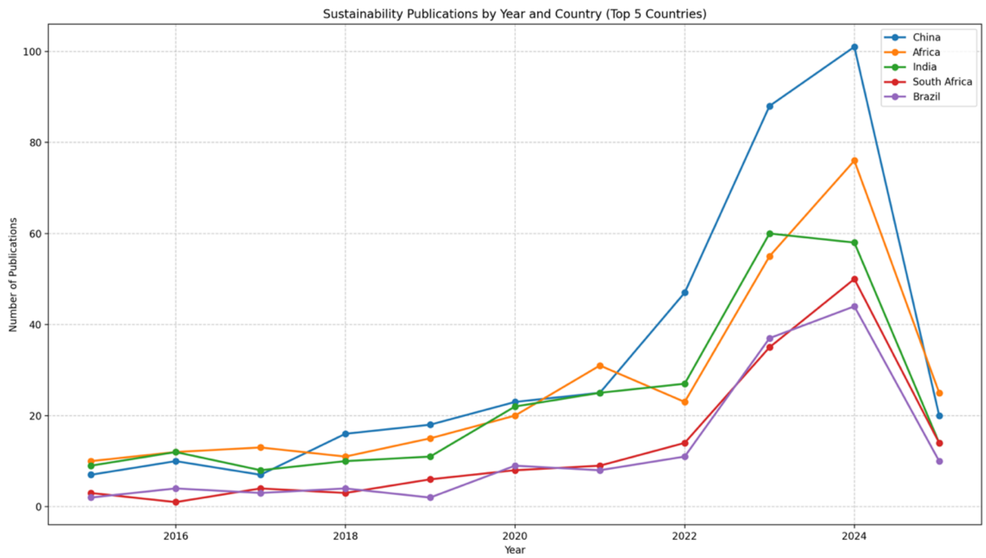

Figure 1. *Trends in the Publication of Sustainability Topics by Country and Year*

Co-Citation Analysis

From the 254,999 cited references derived from the database, 60 meet the threshold of a minimum of 11 cited references. The threshold was tested several times until robust, evenly distributed clusters were formed. This analysis tested several values (3, 4, 6, 7, and 8) until the best visualization was achieved. The threshold must be appropriate, not too high or too low, which can result in oversimplified or complicated visualization. The highest co-cited publications are Testing (2007) (30 citations), Pesaran (2007) (29 citations), and Perasan (31 citations). Table 3 presents the top 10 highest co-cited documents and their total link strength based on the co-citation analysis. Total link strength is a document linked to other documents (van Eck & Waltman, 2014).

Table 1. *Top 10 Documents with the Highest Co-Citation and Total Link Strength*

Documents	Citation	Total Link Strength
Westerlund J., Testing for Error Correction in Panel Data, Oxford Bulletin of Economics and Statistics, 69, 6, pp. 709-748, (2007)	30	88
Pesaran M., A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence, Journal of Applied Econometrics, 22, 2, pp. 265-312, (2007)	29	86
Pesaran M., Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure, Econometrica, 74, 4, pp. 967-1012, (2006)	31	83
Pesaran M., Yamagata T., Testing Slope Homogeneity in Large Panels, Journal of Econometrics, 142, 1, pp. 50-93, (2008)	27	78
Pesaran M., A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence, J. Appl. Econom., 22, 2, pp. 265-312, (2007)	29	70
Im K., Pesaran M., Shin Y., Testing for Unit Roots in Heterogeneous Panels, Journal of Econometrics, 115, 1, pp. 53-74, (2003)	24	67
Pedroni P., Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis, Econometric Theory, 20, 3, pp. 597-625, (2004)	21	54
Pesaran M., Yamagata T., Testing Slope Homogeneity in Large Panels, J. Econom., 142, 1, pp. 50-93, (2008)	19	48
Chudik A., Pesaran M., Common Correlated Effects Estimation of Heterogeneous Dynamic Panel Data Models with Weakly Exogenous Regressors, Journal of Econometrics, 188, 2, pp. 393-420, (2015)	15	46
Pesaran M., General Diagnostic Tests for Cross-Section Dependence in Panels, (2004)	28	44

Based on the network visualization, co-citation analysis produces five distinct clusters. Figure 2 illustrates the network structure in the co-citation analysis. Each cluster is labelled and characterized based on the representative publications according to the author's inductive interpretation and understanding of the five clusters.

Figure 2. *Co-Citation Analysis of Big Data Analytics in Sustainability*

An unexpected and significant observation of the co-citation analysis is the high prominence of the econometric methods papers, especially by Pesaran et al., which are the most co-cited items. This indicates that the research horizon of technology-induced sustainability in many developing countries is heavily biased toward quantitative, panel data-driven analysis. The center of gravity is down-weighted at the heart of this field (intellectually represented in the co-citation pattern). Instruments tend to focus more on the econometric tools necessary for testing and measuring relationships between variables, rather than exploring more foundational sustainability or technology adoption theories. This means that we are in a field that is very focused on establishing empirical evidence and causation, probably because that is what is demanded to influence policy. The relation between these methodological papers and the thematic clusters is that these econometric instruments are the lens through which the authors address the subject of their clusters.

Cluster 1 (Red): Underpinning Theories and Methodologies in Technology-Driven Sustainability. This cluster gathers key works that delineate the theoretical and methodological approach to how technology can promote sustainability in the Global South. Although some building block theories, such as Ajzen's (1991) Theory of Planned Behavior and Rogers' (1995) Diffusion of Innovations, are part of this cluster, the operationalization of this cluster in the dataset draws heavily from the quantitative approaches housed in this cluster as well. For instance, in the studies of Fornell and Larcker (1981) and Hair et al. (2019), we offer theoretical instruments to audit the adoption and effect of technology from Venkatesh et al. (2003) and others. As such, this cluster reflects the theoretical and methodological "tools" researchers in this area apply to design their empirical work.

Cluster 2 (Green): Econometric Tools for the Analysis of the Sustainability in Developing Countries. This cluster is the most clear sign of the field's methodological bias. It highlights the indispensable role of econometric methods in examining complex relationships between technology, economic growth, and sustainability in developing countries. The fact that dynamic panel data models and techniques for detection and treatment of cross-sectional dependence from Arellano and Bond (1991), Blundell and Bond (1998), and Chudik and Pesaran (2015) are now very popular demonstrates that the field is wrestling with the complexities of extensive longitudinal data in a networked global world. These are not mere tools in the abstract, but the things researchers will use to investigate the long-term relations and causal pathways covered in the remaining thematic clusters. The dominance of this cluster indicates that much of the particular contribution of many papers in this area is their use of advanced econometric methods in the analysis of sustainability issues.

Cluster 3 (Blue): Energy Transitions and Sustainability in Developing Countries. The cluster's mission is to address the imperative need for energy transitions to be the conduit through which sustainability should be achieved, especially in the developing world. The relationship to the methodological orientation of the entire dataset could hardly be stronger: researchers who study the effects of renewable energy adoption on things such as economic growth and environmental outcomes are using the econometric methods featured in Cluster 2. For instance, Pesaran (2006, 2007) and Dumitrescu and Hurlin (2012) are adapted to examine the causality ordering between the social cornerstone of renewable energy (Wüstenhagen et al., 2007) and environmental pro of Pata and Caglar (2021). This cluster illustrates how the methodological heart yard of the discipline can be brought to bear on one of the most significant challenges in sustainable development.

Cluster 4 (Yellow): Technology and Resources, and Environmental Sustainability. This cluster examines how technology, resources, and economic growth interact to achieve environmental sustainability, particularly concerning developing economies. The studies within this cluster, such as Ahmad et al. (2020) and Balsalobre-Lorente et al. (2018), ask questions on the effect of technological innovation on ecological footprint and CO2 emissions." Such studies in Cluster 2 represent the type of research that advanced panel data methods can address. These include methodological papers by Chudik and Pesaran (2015), Im et al. (2003), and Westerlund (2007). In this conjunction, there is a clear consequence of this reliance. It demonstrates that research on ICT and SDGs (Chien et al., 2021) is mostly perceived in terms of econometric puzzles.

Cluster 5 (Violet): Circular Economy, Waste Management, and Sustainability Decision-Making. This cluster emphasizes waste management, the circular economy, and decision-making frameworks important for sustainability in developing countries. This cluster is distinct in that it combines a macro perspective of waste management trends analysis (Hoornweg & Bhada-Tata, 2012; Kaza et al., 2018) with particular decision support tools such as Saaty's (1980) Analytic Hierarchy Process (AHP) and Rezaei's (2015) Best-Worst Method. Whereas the other clusters primarily encompass econometric-oriented conceptions of sustainability, this cluster indicates a more pragmatic and operational orientation. The relevance to the broader results is that although simply estimating a CAPM econometric model can identify the why (e.g., why waste causes constraints on economic growth), the decision-making elements in this set give the how (e.g., how to list solid waste management programs in a prioritized manner).

The objective of the bibliometric analysis was merely to chart the intellectual and thematic structure of technology-driven sustainability research in the developing countries. The results of both the co-citation and co-word analyses suggest a methodologically complex but theoretically limited field, with important implications for understanding sustainable development and efforts to advance it. Perhaps most notable is the presence of econometric methodology papers in the co-citation analysis. It is not the theoretical foundation of sustainability but the statistical instruments to measure it that form this research field's rationale. This has several implications. On the one hand, it demonstrates a field that is so well settled and rigorous that it puts evidence and cause at the center. This is a strength in a world where policy decisions must be data-driven. On the other hand, this poses an important "so what?" question: If methodological rigor has been near universal in its deployment, are we squeezing out other, more varied theoretical and qualitative perspectives necessary to grasp the multiple social, cultural, and political dimensions of sustainability? The co-word analysis confirms this, though "sustainable development" and "developing countries appeared amongst the first in co-occurrence, yet gravitated toward economic and energy-related topics.

The relation among the clusters makes this dynamic clear. The econometric methodologies that defined Cluster 2 are the main drivers of the research in Clusters 3 and 4, which are concerned with energy transitions and resource governance. This exposes a research pipeline in which sustainability problems are recast as econometric problems that need to be addressed by panel data models. Although it is powerful, this level of understanding is too high. It may neglect the subtleties of local context and human behavior central to the bodies of theories in Cluster 1, including the Theory of Planned Behavior or Development as Freedom.

There is a gap between the rich theoretical and qualitative resources and the dominant quantitative, model-oriented research in the field. Cluster 5, which focuses on the circular economy and decision-making tools such as the Analytic Hierarchy Process, may bridge the gap between high-level econometric modelling and on-the-ground practice. This factor indicates a more practical, problem-solving orientation in addition to the empirical research. For example, an econometric study may determine the most significant factors related to waste generation. However, AHP can help local authorities allocate investment in specific waste management. Unsurprisingly, AHP is useful for environmental policies and waste management searches for alternatives (Mavrotas & Diakoulaki, 2003). This underscores the importance of additional research to format these various approaches.

Table 2 summarizes the co-citation analysis by presenting its clusters, cluster labels, number of articles, and representative publications.

Table 2. *Co-Citation Clusters on Big Data Analytics in Sustainability*

Cluster	Cluster Label	Number of Articles	Representative Publications
1 (Red)	Foundational Theories and Methodologies in Technology-Driven Sustainability	14	Ajzen (1991), Rogers (1995), Venkatesh et al. (2003), Barney (1991), Sen (2014), Braun & Clarke (2006), Bryman (2016), Fornell & Larcker (1981), Hair et al. (2019), & Ghobakhloo (2020).
2 (Green)	Econometric Tools for Understanding Sustainability in Developing Countries	12	Arellano & Blund (1991), Blundell & Bond (1998), Chudik & Pesaran (2015), Kao (1999), Pedroni (2004), Westerlund (2007), Grossman & Krueger (1995), & Pesaran & Yamagata (2008).
3 (Blue)	Energy Transitions and Sustainability in Developing Countries	9	Bridge et al. (2013), Wustenhagen et al. (2007), Pesaran (2007), Eberhardt & Bond (2009), Dumitrescu & Hurlin (2012), Pata & Caglar (2021) & Usman & Balsalobre-Lorente (2022).
4 (Yellow)	Technology, Resources, and Environmental Sustainability	8	Ahmad et al. (2020), Balsalobre-Lorente et al. (2018), Chien et al. (2021), Chudik & Pesaran (2015), Im et al. (2003), Westerlund (2007), & Sun et al. (2022).
5 (Violet)	Circular Economy, Waste Management, and Decision-Making for Sustainability	8	Hoornweg & Bhada-Tata (2012), Kaza et al. (2018), Kirchherr et al. (2017), Radjou et al. (2012), Saaty (1980) & Sayes (2015).

Co-Word Analysis

The co-word analysis applies to the same database. From the 23567 keywords, 60 met the minimum of 105 occurrences, resulting in 3 clusters. The highest co-occurrence keywords are sustainability (1993), developing countries (1803), and sustainability (1163). Table 5 summarizes the top 15 co-occurred keywords with their number of occurrences and total link strength.

Table 3. *Top 15 Keywords in the Co-Occurrence of Keywords Analysis*

Ranking	Keyword	Occurrences	Total Link Strength
1	Sustainable development	1993	8109
2	Developing countries	1803	7001
3	Sustainability	1163	4260
4	Developing world	609	3003
5	China	367	2520
6	Human	420	2366
7	Article	296	2081
8	Developing country	332	2031
9	Climate change	386	1981
10	Renewable energy	292	1940
11	Economic development	251	1874
12	Innovation	347	1845
13	Carbon dioxide	221	1800
14	Economics	274	1744
15	India	245	1730

Figure 3 presents the network map of the co-word analysis. The map produces three clusters and is classified and labeled based on the author's inductive interpretation of the occurring words. All the clusters are shown to be closely related and partially integrated.

Cluster 1 (Red): This cluster is named "Sustainable Energy and Economic Development" and includes 22 keywords. The first keyword cluster concerns the linkage of renewable energy, energy efficiency, and economic development in developing countries (Han et al., 2025). The themes commonly found in this cluster are all about how carbon-neutral and carbon-free technologies contribute to/impact developing countries in switching to alternative energy and in radical transformations of the economic and social sectors—the Role of Energy Policy in Transition. The transition from one energy source to another, like fossil fuels to renewables, must be analyzed under energy policy, or investments must be made to encourage the switch to reach specific goals. Ahmed (2024) adds that decision-makers consider the trade-off between economic analysis and environmental management. In this regard, it is critical to plan the integration of renewable energy sources in national grid infrastructures to make the most of them and comply with increasing load factors. Furthermore, energy paradigms have a tremendous influence on trade and the economy. Implementing environmental technologies improves energy efficiency, minimizes greenhouse gases, and ameliorates climate change (Kevat, 2025). However, the viability of such shifts would depend on financial structures providing for cleaner energy efforts, particularly in poorer countries. Another important aspect of this cluster is the impact of energy on the environment. The trade-offs that developing countries will make between industrialization and the environment. Technological innovations can increase countries' economic resilience and environmental sustainability through the correct policy measures promoting sustainable structures of a new economy. This group highlights why technology-driven energy solutions need a supportive and self-sustaining economic model, and the importance of long-term renewable energy infrastructure planning and investment.

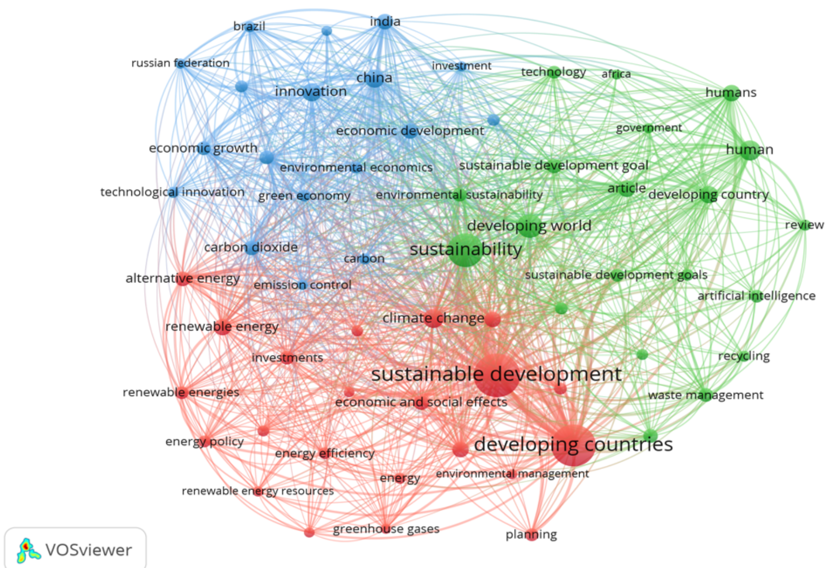

Figure 3. *Network Map of Co-Word Analysis*

Cluster 2 (Green): This cluster is called "Technology, Sustainability, and Governance in Developing Countries". The initial cluster of keywords reveals how technology, environmental sustainability, and governance intersect to achieve sustainable development in developing countries. One of the hot topics in this cluster relates to the involvement of AI and technology-enabled decision-making in waste recycling and agriculture. They indicate the larger vision associated with the circular economy, where resources are used and reused effectively so that the environment has as little impact as possible (Clifton, 2025). There has been a surge in high-tech sustainability endeavors in the Global South, especially in Africa. AI in agriculture helps boost productivity with precision farming, and innovative waste management systems help preserve the environment by reducing pollution and encouraging recycling. The solutions align with the broader goal of environmental sustainability: that economic advancement should not be at the detriment of ecological harmony (Charamba, 2025). Governments are key actors who help design successful policies for sustainable development through research and review articles to inform policy. Ensuring their participation in planning and decision-making is crucial to designing regulations regulating the trend toward eco-compatible industrial processes and urban development. However, issues like limited resources and socioeconomic barriers hinder the spread of these technologies. This cluster emphasizes the interplay between technological innovation, policy mechanisms, and sustainability initiatives in the developing world. If nations harness AI and create waste management solutions and circular economies, they can support long-term environmental and economic resiliency.

Cluster 3 (Blue): This cluster is named "Technological Innovation and Green Economy in Developing Countries". This keyword cluster also appears to reflect the links between technological change, economic growth, and environmental sustainability in several large emerging markets, including Brazil, China, and India. These countries are pivotal to the future of the green economy as early adopters of technology and investors in sustainable solutions. One of the significant trends in this cluster is the focus on pollution and carbon dioxide reduction, as economic growth often leads to environmental degradation, resulting in increased carbon emissions. Industrial growth and environmental economy considerations in countries like China and India would fulfill their needs with technological advancement. Innovation in clean energy, carbon capture technology, and policy-based emission control measures was deemed necessary to mitigate environmental impacts and support ongoing economic development (Wang et al., 2021). A further important component of this cluster is investment in technology development. The governments and business communities in these developing economies are investing resources in green technologies, like renewable energy, smart grids, and energy-efficient industrial processes. For instance, Brazil has pioneered in the biofuel sector but is a power in research and development, whilst China has strategically invested in solar and wind technologies (Crijns-Graus et al., 2009). The maturation of the green economy in these emerging nations highlights the power of technology, policy, and investment in sustainable progress. With the advancement of technology and the extension of its coverage, promoting low-carbon technologies and environmental policies will be influential in developing economies under global climate change.

Table 4 summarizes the co-word analysis, represented by its cluster label, number of keywords, and representative keywords.

Table 4. *Co-Word Analysis on Social Media in Sustainability*

Cluster No. and Colour	Cluster Label	Number of Keywords	Representative Keywords
1 (Red)	Sustainable Energy and Economic Development	22	Alternative Energy, Climate Change, Environmental Impact, Renewable Energy, and Sustainable Development
2 (Green)	Technology, Sustainability, and Governance in Developing Countries	20	Developing Country, Environmental Sustainability, Technology, and Waste Management
3 (Blue)	Technological Innovation and Green Economy in Developing Countries	18	Economic Development, Economic Growth, Technological Development, and Technology Adoption

Theoretical Implications

This paper also provides important knowledge concerning theory and practical views from technology-based sustainable development in developing countries. On a theoretical level, this research leverages established models such as Ajzen's (1991) Theory of Planned Behavior, Rogers' (1995) Diffusion of Innovations, and Venkatesh et al. 's (2003) Unified Theory of Acceptance and Use of Technology (UTAUT). Such theories explain why people and organizations adopt sustainable technologies and how these technologies spread. By blurring these views, the study contributes to a nuanced understanding of how technology might tackle sustainability problems in various settings (van Eck & Waltman, 2014; Ghobakhloo, 2020). It further points to the necessity of advanced methods of analysis, such as econometric models (Arellano & Bond, 1991; Blundell & Bond, 1998) and cointegration analysis (Pedroni, 2004; Westerlund, 2007) for exploring intricate phenomena, such as the long-run effects of technology adoption on sustainability. These approaches reinforce the contribution to future study work (Chudik & Pesaran, 2015). Moreover, this paper also seeks to reveal strategic research domains, such as renewable energies, circular economy, and green innovation, indicating a good pathway on how the sustainability research body of knowledge is being shaped (Zupic & Čater, 2015).

Practical Implications

The research extends actionable advice to policymakers, companies, and sustainability-oriented organizations. It highlights the significance of aligning technology with sustainable policies such as renewable energy and the circular economy. These findings strongly indicate that governments should devise effective policies supporting economic growth and environmental conservation, such as investing in clean energy provision and upgrading waste management facilities (Hoornweg & Bhada-Tata, 2012; Kirchherr et al., 2017). The paper also highlights how technological changes (e.g., AI, ICT) might contribute to sustainability and environmental goals. These approaches can facilitate waste treatment as a source of energy production and for agricultural yield (particularly in low-resource contexts) (Chien et al., 2021; Clifton, 2025). To address sustainability issues, the study emphasizes the need for collaboration, highlighting the importance of holistic partnerships between governments, the private sector, and the international community. For instance, research on energy transition indicates the need for a greater emphasis on sharing knowledge and capacity building for more effective adoption of renewable energy technologies in developing countries (Bridge et al., 2013; Wüstenhagen et al., 2007). Finally, the investigation offers some practical tools for decision-making, such as the Analytic Hierarchy Process (Saaty, 1980) and the Best-Worst Method (Rezaei, 2015), in order to support policymakers and companies in determining which sustainability initiatives to pursue and how to allocate resources efficiently. In summary, this study enhances our knowledge and understanding of how technology can address sustainability. It presents real-world problems and concrete strategies for addressing them — a solid foundation for future research and action.

4.0 Conclusion

This research took a bibliometric approach to explore the intellectual and conceptual structure of technology-enabled sustainability research - particularly in developing countries. The analysis uncovers a discipline with a powerful and sophisticated methodological mainstream, almost exclusively based on econometric methods. The most broadly cited works that underpin this research field are not foundational treatises on sustainability or technology, but the advanced statistical techniques enabling empirical investigation. This suggests that the field values rigorous, evidence-based analysis of the interaction between technology, economic development, and environmental impact, presumably to inform policy efforts.

This methodological emphasis has two consequences. On the other hand, it indicates a mature and sound field of study that can generate causal knowledge and inform evidence-based policy making. On the other hand, it prompts a reflection on the risk of marginalization of different theoretical frameworks or qualitative approaches that have the potential to enrich the conceptualization of sustainability. The research topics, referred to as fields of study, are developed around key issues including energy transitions, resource management, and the circular economy, and are largely approached via quantitative approaches. This gap between rich, context-based social theories of technology adoption and the macro-level empirical models that dominate the field has the potential to be problematic.

In the end, this paper constructs a map of material and labor to illuminate a critically essential and quickly changing area of research. Emphasizing econometric predominance and thematic foci, the study highlights a profound tension between methodological strictness and theoretical sprawl. At the same time, the paper highlights the opportunity to develop a more integrated and multifaceted research agenda. Connecting the dots between sophisticated quantitative analysis and context-sensitive, nuanced qualitative investigation is the next frontier in advancing the theory and practice of technology-driven sustainability in the developing world. Given these results, further research must focus on developing a more methodologically diverse and theoretically grounded scenario. Researchers should transcend a narrow econometric approach and incorporate a qualitative and mixed methods research design that can capture the rich social, cultural, and political dynamics that drive sustainability outcomes. There is much room for work that closely and explicitly links theoretical foundations of innovation diffusion and user acceptance claims with empirical analysis, thus allowing us to close the current gap between theory and evidence. In addition, promoting interdisciplinary dialogue amongst economists, sociologists, engineers, and policy researchers is essential to move towards more comprehensive and applicable responses grounded in empirical fact and practical to developing nations' particular challenges.

5.0 Contributions of Authors

Author 1: Conceptualization, data gathering.
Author 2: Conclusions and recommendations.
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9.0 References

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