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Circular Economy Governance and Research Development in Southeast Asia: A Scientometric and Comparative Recycling Governance Analysis of the Philippines and Romania

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ABSTRACT: The transition toward a circular economy has become a major policy response to growing concerns over resource depletion, plastic pollution, and the environmental impacts of linear production and consumption systems. Although circular economy research has expanded rapidly during the past decade, existing studies often examine research development and governance performance separately, limiting understanding of how knowledge production relates to the institutional conditions that shape recycling transitions. Comparative evidence linking Southeast Asian circular economy development with emerging European experiences remains limited. This study integrates scientometric analysis and comparative environmental-governance assessment to examine circular economy research development in Southeast Asia and recycling governance in the Philippines and Romania. Scientometric analysis was conducted using 3,678 Scopus-indexed publications published between 1971 and 2025. Publication trends, thematic evolution, and collaboration networks were analyzed using Bibliometrix, Biblioshiny, and VOSviewer. Comparative governance assessment was based on policy documents, institutional reports, and secondary datasets related to recycling infrastructure, policy implementation, resource recovery, and institutional coordination. The results revealed a substantial increase in circular economy scholarship after 2015, with research activity concentrated in a small number of regional hubs, particularly Indonesia (820 publications) and Malaysia (650 publications). Thematic analysis indicated a shift from conventional waste-management research toward broader themes involving sustainability transitions, environmental governance, resource efficiency, and circular business models. Collaboration-network analysis demonstrated moderate regional connectivity (network density = 0.36) but also highlighted uneven participation among Southeast Asian countries. Comparative assessment revealed marked differences in recycling governance between the Philippines and Romania. Romania achieved a substantially higher composite recycling-performance score (4.14) than the Philippines (2.14), reflecting stronger institutional coordination, regulatory enforcement, recycling infrastructure, and resource-recovery integration associated with European Union policy alignment and the implementation of a national Deposit Return System. In contrast, recycling governance in the Philippines remains constrained by uneven implementation capacity, infrastructure limitations, and fragmented institutional arrangements despite the presence of comprehensive environmental legislation. By linking research development with

governance performance, the study provides a broader perspective on how institutional conditions influence circular economy transitions. The findings underscore the importance of governance coherence, infrastructure investment, and sustained policy implementation in advancing resource recovery and environmental sustainability in developing and transitioning economies.

1. INTRODUCTION

Plastic pollution and inefficient resource use have emerged as major environmental challenges worldwide. Rapid growth in population, urbanization, industrial production, and material consumption has resulted in increasing volumes of municipal and industrial waste, placing significant pressure on ecosystems and natural resources. Global plastic production has more than doubled over the past two decades, while waste generation continues to outpace the capacity of many countries to effectively collect, recycle, and recover discarded materials (OECD, 2022). As a consequence, large quantities of plastic waste continue to accumulate in landfills or leak into terrestrial and aquatic environments, contributing to biodiversity loss, ecosystem degradation, and greenhouse-gas emissions (Geyer et al., 2017; UNEP, 2023). These challenges have intensified interest in the circular economy (CE), an economic model that seeks to reduce waste generation and retain the value of materials through reuse, repair, remanufacturing, recycling, and resource recovery. Unlike the conventional linear model of production and consumption, the circular economy promotes closed-loop material flows that support environmental sustainability and long-term resource efficiency (Geissdoerfer et al., 2017; Kirchherr et al., 2017).

Southeast Asia has become an important region in discussions on circular economy implementation because of its rapid economic growth, expanding urban populations, and increasing consumption of resource-intensive products. While these developments have contributed to economic progress, they have also generated growing volumes of solid waste and plastic pollution that challenge existing waste-management systems. Several countries in the region continue to experience limitations in waste collection, recycling infrastructure, and policy implementation, resulting in substantial environmental leakage into rivers, coastal zones, and marine ecosystems (Lau et al., 2020; Meijer et al., 2021). In response, ASEAN member states have increasingly incorporated circular economy principles into regional and national development strategies, recognizing the importance of resource efficiency, waste reduction, and sustainable production in achieving long-term environmental and economic objectives (ERIA, 2024). Nevertheless, implementation outcomes remain uneven across the region because of differences in institutional capacity, governance arrangements, technological development, and financial resources (ERIA, 2024; World Bank, 2021).

Romania provides a valuable comparative context for examining circular economy governance and recycling transitions. As a member of the European Union (EU), Romania has aligned its environmental policies with broader European initiatives, including the Circular Economy Action Plan and waste-management directives that emphasize resource efficiency, recycling, and sustainable consumption (European Commission, 2022). In recent years, the country has undertaken significant reforms to improve waste collection and recycling performance, most notably through the implementation of a national Deposit Return System (DRS) in 2023. Early assessments indicate that the DRS has strengthened collection mechanisms for beverage packaging, improved traceability, and increased participation in recycling activities (EEA, 2024). Although Romania continues to face challenges associated with regional disparities and infrastructure development, its experience demonstrates how policy coordination, regulatory enforcement, and economic incentives can support circular economy transitions in emerging economies.

Recent comparative studies have shown that circular economy implementation differs substantially across countries because of variations in governance systems, institutional capacity, regulatory frameworks, infrastructure availability, and socio-economic conditions. Comparative assessments conducted across developed and developing economies consistently indicate that countries with stronger policy coordination, stable financing mechanisms, and well-developed recycling infrastructure generally achieve higher levels of material recovery and recycling performance. In contrast, emerging and transitioning economies frequently encounter barriers related to governance fragmentation, limited institutional capacity, inadequate technological infrastructure, and weak enforcement mechanisms (Akomea-Frimpong et al., 2024). Studies examining recycling transitions further emphasize that effective circular economy implementation depends on long-term institutional commitment, stakeholder coordination, and the alignment of environmental policies with local development contexts (EEA, 2024; OECD, 2024). These

findings suggest that circular economy transitions are highly context-dependent and that successful implementation requires more than the adoption of environmental legislation alone.

Alongside governance-oriented research, scientometric and bibliometric investigations have expanded rapidly as scholars seek to understand the evolution of circular economy knowledge. Recent studies have documented substantial growth in circular economy publications, increasing interdisciplinary diversification, and the emergence of research themes related to sustainability transitions, industrial ecology, resource efficiency, environmental governance, and circular business models (Dominko et al., 2023; Şahin, 2024). Scientometric analyses have also revealed the growing importance of collaboration networks, thematic convergence, and knowledge diffusion in shaping the development of circular economy scholarship (Gomis et al., 2022). While these studies provide valuable insights into publication trends and research evolution, they primarily focus on knowledge production and scientific performance. Conversely, governance-oriented investigations typically concentrate on policy implementation, institutional effectiveness, and operational recycling systems. Consequently, limited attention has been given to how evolving research agendas relate to the institutional conditions that shape recycling governance and resource-recovery transitions, particularly in developing and transitioning economies.

Despite the growing body of literature on circular economy development, important knowledge gaps remain. Existing scientometric studies have largely examined research growth, thematic evolution, and collaboration patterns without exploring how these knowledge systems relate to governance performance and recycling outcomes. At the same time, comparative governance studies have generally focused on policy implementation and institutional arrangements without considering broader patterns of research development. As a result, the interaction between knowledge production and recycling governance remains insufficiently understood, particularly in developing and transitioning economies. Furthermore, comparative studies linking Southeast Asian circular economy development with emerging European transition experiences remain limited. This study addresses these gaps by integrating scientometric mapping with comparative environmental-governance analysis to examine both the development of circular economy scholarship in Southeast Asia and the institutional conditions shaping recycling governance in the Philippines and Romania.

Accordingly, this study aims to examine circular economy research development and recycling governance through an integrated analytical framework. Specifically, the study seeks to: (1) analyze publication growth, thematic evolution, and collaboration networks within Southeast Asian circular economy scholarship; (2) evaluate and compare recycling governance systems in the Philippines and Romania with respect to policy implementation, institutional coordination, infrastructure development, and resource-recovery mechanisms; and (3) explore how knowledge development and governance conditions collectively influence circular economy transitions. In this study, the broader Southeast Asian context is examined through scientometric analysis, while the comparative governance assessment focuses specifically on the Philippines and Romania. By linking knowledge production with institutional realities, the study contributes a more comprehensive understanding of circular economy transitions and their implications for environmental governance and sustainability policy.

2. METHODOLOGY

2.1 Research Design

This study employed an integrated mixed-method design combining scientometric analysis and comparative environmental-governance assessment. The approach was developed to examine both the evolution of circular economy scholarship in Southeast Asia and the operational conditions influencing recycling governance in the Philippines and Romania. The integration of these approaches allowed the study to examine how knowledge production, institutional systems, and recycling implementation interact within emerging circular economy transitions.

The scientometric component focused on identifying publication trends, thematic development, collaboration structures, and research patterns within Southeast Asian circular economy literature. The comparative component examined governance conditions, policy implementation, recycling infrastructure, and institutional coordination in the Philippines and Romania. Combining these analytical perspectives enabled interpretation of publication trends alongside governance realities observed in the two comparative cases.

The methodological approach was informed by previous scientometric and sustainability-transition studies that emphasize the importance of linking knowledge systems with institutional and governance analysis in environmental-transition research (Aria and Cuccurullo, 2017; Donthu et al., 2021; Köhler et al., 2019).

2.2 Scientometric Data Collection

Bibliographic data were retrieved from the Scopus database because of its broad coverage of peer-reviewed international literature and its suitability for bibliometric and science-mapping analysis. The search process was conducted in January 2026 using combinations of keywords related to circular economy research and Southeast Asian environmental governance.

The search query included terms associated with circular economy concepts, recycling systems, waste management, and sustainability transitions combined with ASEAN geographical identifiers. The search was limited to English-language publications indexed in Scopus between 1971 and 2025. Document types included journal articles, conference papers, review articles, and book chapters.

The following search structure was applied:

TITLE-ABS-KEY (“circular economy” OR recycling OR “resource recovery”

OR “waste management” OR “sustainability transition”)

AND

TITLE-ABS-KEY (“Southeast Asia” OR Philippines OR Indonesia

OR Malaysia OR Thailand OR Vietnam OR Singapore

OR Cambodia OR Laos OR Myanmar OR Brunei)

The initial Scopus retrieval yielded 4,216 records. A multi-stage screening and metadata-cleaning procedure was subsequently conducted. Duplicate records ($n = 142$), non-English publications ($n = 96$), records with incomplete metadata ($n = 58$), and publications not directly related to circular economy, recycling governance, or resource recovery ($n = 242$) were excluded. After screening, the final dataset consisted of 3,678 Scopus-indexed publications that were used for the scientometric analyses.

Table 1. Screening and selection process for the scientometric dataset

Screening Stage	Records
Initial retrieval	4,216
Duplicates removed	142
Non-English publications removed	96
Incomplete metadata removed	58
Irrelevant publications removed	242
Final dataset	3,678

2.3 Scientometric Analysis

Scientometric analysis was conducted using Bibliometrix, Biblioshiny, and VOSviewer. Bibliometrix and Biblioshiny were primarily used to examine annual scientific production, source productivity, author participation, citation structures, keyword frequency, and thematic evolution within the literature. VOSviewer was employed to construct visualization networks involving co-authorship relationships, institutional collaboration patterns, citation structures, and keyword co-occurrence networks. For country-level collaboration analysis, only countries with at least 20 publications were included in the network to improve visualization clarity and emphasize the most active contributors to regional circular economy research.

The analysis focused on identifying dominant research themes, publication growth patterns, interdisciplinary development, and shifts in thematic orientation over time. Particular attention was given to the transition from conventional waste-management themes toward broader sustainability-transition, governance, and circular-production discussions within Southeast Asian scholarship.

Co-occurrence analysis was used to identify recurring thematic clusters and relationships among frequently used keywords. For keyword co-occurrence analysis, only keywords appearing at least 10 times within the dataset were included in the network visualization. Collaboration-network analysis was additionally conducted to examine institutional and country-level research linkages within the region. Temporal mapping procedures were further applied to assess changes in thematic focus and research concentration across different publication periods.

The scientometric procedures followed commonly applied bibliometric approaches in sustainability and environmental-governance research (Merli et al., 2020; Moral-Muñoz et al., 2020).

2.4 Comparative Environmental-Governance Analysis

The comparative component of the study examined recycling governance systems in the Philippines and Romania. The two countries were selected because they represent contrasting governance and institutional conditions within emerging circular economy transitions. The Philippines reflects a developing Southeast Asian context characterized by fragmented implementation systems, infrastructural disparities, and dependence on informal waste sectors. Romania, in contrast, represents a transitioning European context influenced by European Union environmental-policy alignment, stronger regulatory coordination, and recent implementation of a national Deposit Return System (DRS).

Comparative analysis focused on policy frameworks, institutional coordination, recycling infrastructure, implementation mechanisms, financing systems, and resource-recovery strategies. To support the comparison, a governance-assessment framework was developed using indicators commonly employed in recycling-governance and circular-economy studies. Seven dimensions were evaluated: recycling rate, recycling-process efficiency, waste-management effectiveness, infrastructure and technological capacity, policy implementation and enforcement, public participation and awareness, and economic incentives for resource recovery. Evidence was synthesized from policy documents, institutional assessments, international agency reports, and peer-reviewed literature. Each indicator was scored on a five-point scale, where 1 represented very weak performance and 5 represented very strong performance. Equal weighting was adopted because no empirical evidence was available to justify differential weighting among governance indicators. Scores were assigned based on the consistency of policy implementation, institutional coordination, infrastructure availability, technological development, and reported recycling outcomes. The framework was intended as a comparative interpretive tool rather than a standardized quantitative index, allowing the identification of relative strengths and weaknesses in recycling governance between the Philippines and Romania.

Data were obtained from secondary sources including government policy documents, OECD and World Bank reports, European Environment Agency assessments, ASEAN and ERIA publications, and peer-reviewed academic literature. Document analysis was employed to identify recurring governance patterns, institutional barriers, implementation challenges, and policy differences between the two countries. Comparative interpretation was guided by sustainability-transition and environmental-governance perspectives emphasizing the role of institutional capacity, policy coherence, and socio-technical coordination in shaping circular economy implementation (Köhler et al., 2019; Centobelli et al., 2024).

2.5 Data Analysis and Interpretation

Findings from the scientometric and comparative analyses were interpreted collectively to examine relationships between regional knowledge development and operational recycling governance. Rather than treating bibliometric indicators as purely quantitative outputs, publication trends and thematic evolution were interpreted within broader environmental-governance and sustainability-transition contexts.

Comparative interpretation additionally enabled identification of similarities and differences in governance coordination, infrastructure investment, policy implementation, and recycling-system effectiveness between the Philippines and Romania. The integrated analysis consequently provided a broader perspective on how institutional conditions and knowledge systems influence circular economy transitions in developing and transitioning economies.

2.6 Research Limitations

Several limitations should be acknowledged. First, the scientometric dataset was limited to English-language publications indexed in Scopus. Relevant studies indexed in other databases or published in local languages may therefore not have been included in the analysis. Second, bibliometric indicators primarily reflect publication and citation patterns and may not fully capture the practical influence of research on governance outcomes and policy implementation.

The comparative assessment also relied mainly on secondary documents and institutional reports, which may differ in reporting standards, data availability, and update frequency across countries. In addition, recycling governance systems continue to evolve, particularly in relation to emerging environmental regulations, technological developments, and circular economy policies. The findings should therefore be interpreted within the temporal scope of the study.

Despite these limitations, the integrated methodological approach provides a broader analytical framework for examining relationships among knowledge production, environmental governance, and recycling transitions within developing and transitioning economies.

3. RESULTS AND DISCUSSION

3.1 Publication Growth and Research Expansion

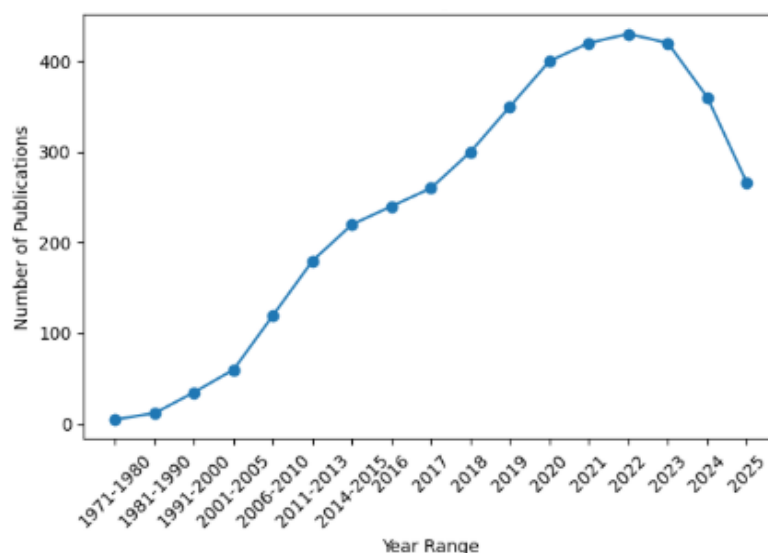


Figure 1. Annual scientific production on circular economy scholarship in Southeast Asia (1971–2025)

Circular economy publications related to Southeast Asia increased substantially between 1971 and 2025 (Figure 1). Publication activity remained low during the early decades but began to increase after the mid-2000s. Growth accelerated markedly after 2015 and reached its highest levels between 2020 and 2022.

The expansion of CE scholarship coincided with increasing regional and global attention to plastic pollution, resource efficiency, climate resilience, and sustainable development. During this period, governments, international organizations, and academic institutions placed greater emphasis on circularity as a strategy for addressing environmental and resource-management challenges. The growing visibility of marine plastic pollution in Southeast Asia also contributed to increased research activity.

The pattern observed in Figure 1 indicates a transition from a relatively narrow focus on waste treatment and recycling operations toward broader discussions of sustainability transitions, environmental governance, industrial ecology, and circular production systems. This shift reflects the maturation of CE research in the region and its growing integration with wider sustainability agendas.

3.2 Geographical Distribution and Regional Research Inequality

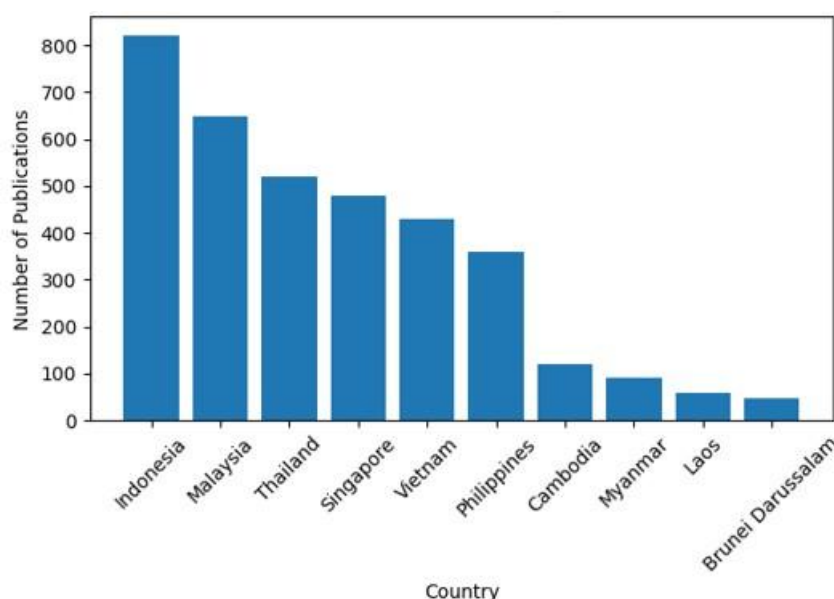


Figure 2. Geographical distribution of circular economy research output in Southeast Asia

Figure 2 shows geographical distribution of circular economy research output in Southeast Asia based on author affiliations (Scopus dataset, $n = 3,678$). The geographical distribution of circular economy research output in Southeast Asia reveals an uneven pattern of scholarly productivity across the region. This concentration indicates disparities in research capacity, institutional support, and access to funding. Countries with higher output are likely more integrated into international research networks and possess stronger academic infrastructures, while lower-output countries may face structural constraints. It is important to note that country-level counts reflect multiple author affiliations per article; therefore, the sum of country contributions exceeds the total number of unique publications analyzed.

Table 2. Leading countries in circular economy research productivity in Southeast Asia

Country	Publications
Indonesia	820
Malaysia	650
Thailand	520
Singapore	480
Vietnam	430

Figure 2 and Table 2 reveal substantial differences in research productivity across Southeast Asia. Indonesia recorded the highest publication output (820 publications), followed by Malaysia (650), Thailand (520), Singapore (480), and Vietnam (430). Together, these countries accounted for most of the regional scientific production on circular economy research.

The concentration of publications within a small group of countries suggests uneven development of research capacity across the region. Countries with higher output generally possess stronger academic institutions, greater access to research funding, and more extensive participation in international scientific networks. In contrast, Cambodia, Laos, Myanmar, and Brunei Darussalam contributed comparatively fewer publications, indicating continuing disparities in research infrastructure and scientific visibility.

These differences have implications beyond publication counts. Countries with higher research output may exert greater influence on regional research priorities and collaborative initiatives. Expanding research participation among less-represented countries would support a more balanced understanding of environmental and resource-management challenges across Southeast Asia.

3.3 Collaboration Networks and Knowledge Structures

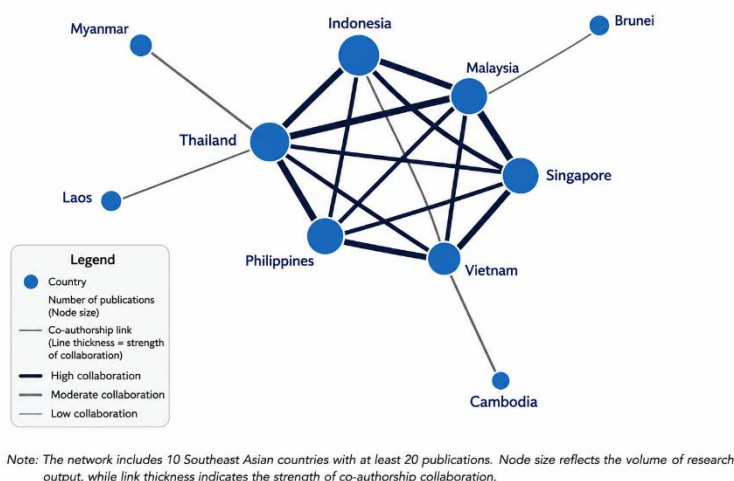


Figure 3. Co-authorship collaboration network among Southeast Asian countries. Source: Author-generated visualization using VOSviewer and Biblioshiny.

Table 3. Network metrics of co-authorship collaboration in Southeast Asia

Metric	Value
Number of nodes	10
Number of links	16
Network density	0.36
Total link strength	34
Number of clusters	3
Most connected country	Malaysia
Strongest collaboration pair	Indonesia – Malaysia

The co-authorship network shown in Figure 3 illustrates the collaborative structure of circular economy research in Southeast Asia. The network comprises 10 countries connected through 16 collaboration links, resulting in a network density of 0.36. These values indicate a moderately connected regional research system.

Malaysia occupied the most central position in the network, while Indonesia, Thailand, Singapore, and Vietnam also formed important collaborative hubs. The strongest partnership occurred between Indonesia and Malaysia, reflecting sustained research interaction and shared participation in regional sustainability initiatives. These countries appear to serve as major centers of knowledge production within Southeast Asian CE scholarship.

Despite the growth of collaborative activity, participation remains uneven. Laos, Cambodia, Myanmar, and Brunei Darussalam were positioned at the margins of the network and maintained fewer collaborative linkages. Strengthening regional partnerships may help reduce disparities in research visibility, improve knowledge exchange, and support broader participation in circular economy research across Southeast Asia.

3.4 Thematic Clusters and Evolution of Circular Economy Scholarship

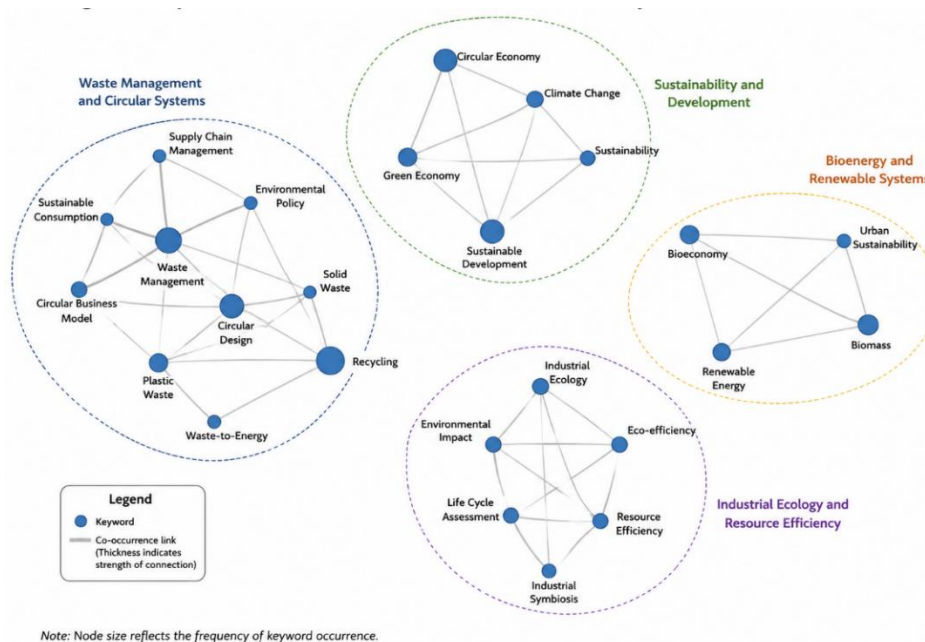


Figure 4. Keyword co-occurrence network of circular economy scholarship in Southeast Asia. Source: Author-generated visualization using VOSviewer and Biblioshiny.

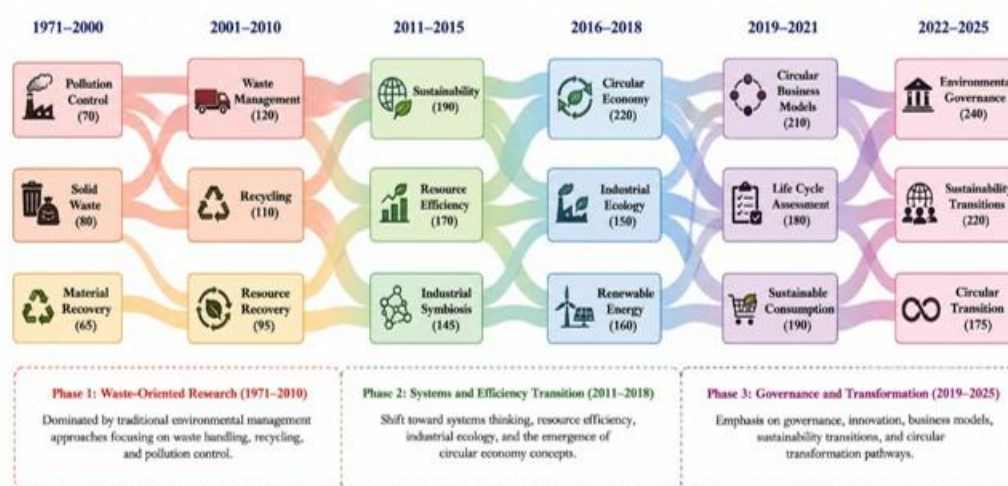


Figure 5. Thematic evolution of circular economy scholarship in Southeast Asia (1971–2025). Source: Author-generated thematic evolution map derived from Biblioshiny analysis of 3,678 Scopus-indexed publications.

Figure 5 presents a synthesized thematic-evolution visualization derived from Biblioshiny thematic outputs and keyword-frequency trends. The figure illustrates the progression of dominant research themes from waste management and pollution control (1971–2010), through resource efficiency and industrial ecology (2011–2018), toward governance, sustainability transitions, and circular transformation (2019–2025). Flow thickness represents the strength of thematic continuity across successive time periods.

Keyword co-occurrence analysis revealed several interconnected research themes within Southeast Asian circular economy scholarship (Figure 4). The largest thematic cluster was centered on waste management, recycling, resource recovery, and solid waste governance, reflecting the long-standing emphasis on addressing growing waste generation and environmental pollution in the region. Additional clusters focused on sustainability, renewable energy, industrial ecology, resource efficiency, environmental management, and circular business practices, indicating the multidisciplinary character of the field.

The thematic evolution analysis (Figure 5) shows a gradual broadening of research interests over time. Earlier studies were largely concerned with waste collection, disposal practices, recycling systems, and pollution control. As the field expanded, attention shifted toward resource efficiency, cleaner production, life-cycle thinking, and industrial symbiosis. More recent publications increasingly address sustainability transitions, environmental governance, circular business models, climate-related challenges, and policy innovation. This progression reflects the growing recognition that circular economy implementation involves institutional, economic, and social dimensions in addition to technical waste-management solutions.

The broadening of research themes reflects how circular economy scholarship has evolved from waste-focused studies toward more systemic sustainability concerns. Rather than focusing solely on end-of-pipe waste management, recent studies increasingly examine systemic approaches that integrate production, consumption, governance, and resource-use efficiency. The emergence of governance and sustainability-related themes further suggests a growing interest in understanding how policy frameworks, institutional arrangements, and stakeholder engagement influence circular economy transitions across the region.

3.5 Comparative Recycling Governance: Philippines and Romania

The comparative scores presented in Table 4 are interpretive analytical indicators synthesized from policy documents, infrastructure conditions, governance implementation evidence, and secondary institutional assessments rather than standardized quantitative indices. The scoring framework was used to facilitate comparative interpretation of governance capacity and recycling-system performance between the two countries.

Table 4. Comparative recycling governance characteristics of the Philippines and Romania

Indicator	Philippines	Romania
Recycling rate	2	4
Recycling-process efficiency	2	4
Waste-management system effectiveness	2	4
Infrastructure and technological capacity	2	4
Policy implementation and enforcement	2	5
Public participation and awareness	3	4
Economic incentives and resource-recovery integration	2	4
Composite RPI score	2.14	4.14

Composite RPI scores were computed as the arithmetic mean of the seven governance indicators.

Table 5. Comparative resource-recovery and recycling-utilization systems

Aspect	Philippines	Romania
Dominant recycling pathway	Low-value reuse	Higher-value material recovery
Industrial integration	Limited	Moderate to high
Market demand for recycled plastics	Developing	More established
Resource-recovery policy integration	Emerging	Stronger institutional integration
Technology adoption	Limited	More advanced

The comparison suggests that material recovery is most effective when supported by stable secondary-material markets, technological innovation, and long-term institutional support. The development of stable secondary-material markets, technological innovation, and regulatory support for recycled products are equally important in sustaining long-term resource recovery.

Evidence from the comparison also shows that economic incentives significantly influence recycling participation and system performance. Romania's DRS provides direct financial motivation for consumers to return recyclable containers, improving collection rates and reducing environmental leakage. In contrast, limited incentive structures in the Philippines reduce participation consistency and place greater dependence on informal recovery systems.

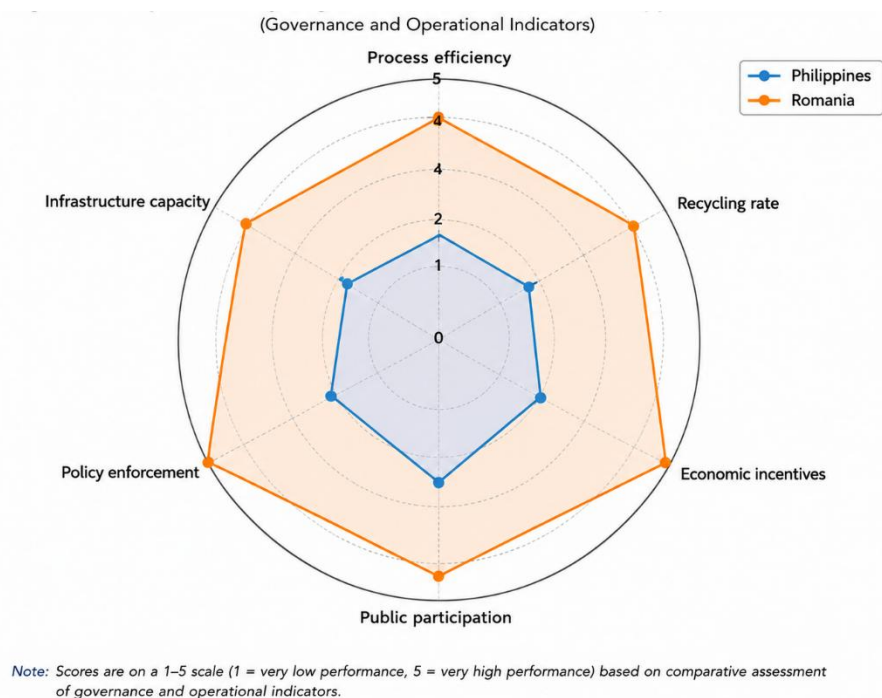


Figure 6. Comparative recycling performance scores between the Philippines and Romania

Figure 6 illustrates the comparative indicator scores between the two countries. The radar chart demonstrates that Romania consistently achieved higher scores across nearly all indicators, particularly in policy enforcement, infrastructure capacity, and recycling-process efficiency. The Philippines showed relatively stronger performance in public participation due to the contribution of informal waste collectors and community-based recycling activities. However, lower scores in technological infrastructure and institutional enforcement limited overall recycling effectiveness. The visual comparison highlights how institutional coordination and infrastructure investment influence overall recycling-system effectiveness.

The comparative assessment revealed substantial differences in recycling governance between the Philippines and Romania (Table 4). Romania achieved a composite recycling-performance index (RPI) of 4.14, compared with 2.14 for the Philippines, indicating stronger institutional capacity and more effective implementation of recycling-related policies.

Romania's performance reflects the influence of European Union environmental directives, which provide a structured policy framework for waste management, recycling targets, and resource recovery. The implementation of the national Deposit Return System (DRS) has further strengthened collection efficiency and increased the recovery of recyclable materials. In addition, the country benefits from more extensive recycling infrastructure, stronger regulatory enforcement mechanisms, and greater integration of economic incentives within waste-management systems.

The Philippines has established a comprehensive legislative framework through measures such as the Ecological Solid Waste Management Act and the Extended Producer Responsibility Act. However, implementation outcomes remain uneven across local government units. Differences in technical capacity, infrastructure availability, financial resources, and institutional coordination continue to affect recycling performance. Informal recycling activities play a significant role in material recovery, yet these activities are not consistently integrated into formal waste-management systems.

The contrast between the two countries illustrates the importance of moving beyond policy adoption toward effective implementation and institutional integration. While both countries have adopted circular economy principles and recycling-

oriented policies, differences in governance capacity, infrastructure development, and regulatory enforcement contribute to markedly different outcomes. These findings highlight the central role of institutional effectiveness in shaping recycling performance and supporting broader circular economy transitions.

3.6 Institutional Asymmetry and Sustainability Transitions

The comparison between the Philippines and Romania highlights how institutional conditions influence the pace and effectiveness of circular economy transitions. Although both countries have adopted policies that promote waste reduction, recycling, and resource recovery, the outcomes differ considerably because of variations in governance capacity, infrastructure development, regulatory enforcement, and stakeholder coordination.

Romania's stronger performance demonstrates the benefits of policy continuity, institutional alignment, and long-term investment in recycling systems. The country's integration within the European Union policy framework has provided clear regulatory targets, monitoring mechanisms, and financial support for environmental initiatives. These factors have contributed to greater consistency in implementation and stronger links between policy objectives and operational outcomes.

In contrast, the Philippine experience illustrates the challenges of translating national policies into local practice. While environmental legislation provides a foundation for circular economy development, implementation remains dependent on the capacities of local government units, the availability of infrastructure, and access to financial and technical resources. Differences in local conditions often result in uneven performance across jurisdictions, limiting the overall effectiveness of recycling initiatives.

Circular economy transitions depend not only on environmental policies but also on the institutional arrangements that support implementation. Effective governance requires coordination among government agencies, private-sector actors, civil society organizations, and local communities. Strengthening these relationships can improve policy execution, encourage resource recovery, and enhance the long-term sustainability of circular economy initiatives. The comparison further demonstrates that institutional capacity remains a critical factor in determining whether circular economy strategies move beyond policy commitments and produce measurable environmental outcomes.

3.7 Implications for Circular Economy Governance in Developing Economies

The findings offer several implications for circular economy governance in developing economies. First, the comparison between the Philippines and Romania demonstrates that policy adoption alone does not guarantee effective recycling outcomes. Institutional capacity, enforcement mechanisms, infrastructure availability, and stakeholder coordination are equally important in determining the success of circular economy initiatives.

Second, the scientometric analysis highlights the need to strengthen research collaboration across Southeast Asia. Although publication output has increased substantially, research activity remains concentrated in a small number of countries. Expanding regional partnerships and supporting research development in underrepresented countries may contribute to a more inclusive and regionally relevant knowledge base for circular economy implementation.

Third, the results underscore the continuing importance of integrating informal waste-recovery systems into formal recycling frameworks. In many developing economies, informal actors play a significant role in material recovery and waste diversion. Policies that recognize and support these contributions may improve recycling efficiency while also generating social and economic benefits.

Finally, future circular economy strategies should adopt a systems-oriented perspective that links technological innovation with governance reform, infrastructure investment, and long-term institutional development. Such an approach may enhance the capacity of developing economies to achieve resource efficiency, strengthen environmental sustainability, and support more resilient circular economy transitions.

CONCLUSION

This study examined the development of circular economy (CE) research in Southeast Asia and compared recycling governance systems in the Philippines and Romania through an integrated scientometric and environmental-governance framework. The analysis revealed that CE scholarship has expanded rapidly since 2015, with research interests evolving from waste management

and recycling toward broader themes involving sustainability transitions, environmental governance, resource efficiency, and circular business models. Despite this growth, research activity remains concentrated in a limited number of Southeast Asian countries.

The comparative analysis revealed clear differences in recycling governance between the Philippines and Romania. Romania demonstrated stronger performance in terms of policy implementation, institutional coordination, recycling infrastructure, and resource recovery, whereas the Philippines continues to face challenges related to uneven implementation capacity and infrastructure limitations. These findings highlight the importance of governance effectiveness in translating circular economy policies into measurable environmental outcomes.

This work contributes to the circular economy literature by linking research development with governance performance. Successful circular economy transitions depend not only on technological innovation and policy commitments but also on institutional capacity, stakeholder coordination, and long-term investment in recycling systems. Although based on the experiences of the Philippines and Romania, the findings provide lessons that may inform circular economy strategies in other developing and transitioning economies pursuing resource efficiency, waste reduction, and sustainable development goals.

Several limitations should be acknowledged. The scientometric analysis was limited to Scopus-indexed publications, while the governance assessment relied primarily on secondary data and policy documents. In addition, the comparative analysis focused on two national case studies, which may limit the broader generalizability of the findings.

Future research may extend this work by incorporating additional countries, longitudinal governance assessments, and primary data from policymakers, industry stakeholders, and local communities. Such efforts would contribute to a deeper understanding of the institutional conditions that support effective circular economy transitions across diverse contexts.

Recommendations

Based on the findings, policymakers should prioritize investments in recycling infrastructure, strengthen enforcement mechanisms, and improve coordination among national and local institutions responsible for waste management. Greater integration of informal recycling actors into formal resource-recovery systems may further enhance recycling efficiency and social inclusion. At the regional level, expanding research collaboration and knowledge-sharing initiatives across Southeast Asia may help reduce disparities in research capacity and support more effective circular economy implementation. Future studies should incorporate primary stakeholder data and longitudinal assessments to better understand how governance reforms influence circular economy outcomes over time.

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Author Contributions

Conceptualization, T.D. and E.W.T.; methodology, T.D. and E.W.T.; formal analysis, T.D. and E.W.T.; investigation, E.W.T. and V.V.G.; data curation, E.W.T.; visualization, E.W.T.; writing—original draft preparation, E.W.T.; writing—review and editing, T.D. and V.V.G.; supervision, T.D. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Data availability statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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