



# Evolving Research Landscape on Eco-Industrial Parks and Local Commodities: A Bibliometric Analysis (2014–2024)

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**Abstract:** This study presents a comprehensive bibliometric analysis of research on eco-industrial parks (EIPs) and local commodities published between 2014 and 2024 using the Scopus database. A total of 1,321 documents were analyzed through VOSviewer to explore publication trends, key authors, countries, institutional collaborations, and thematic structures. Results indicate a steady increase in global research output—particularly after 2018—reflecting growing attention to sustainable industrial transformation and circular economy implementation. However, the analysis reveals that no existing study explicitly connects eco-industrial parks with regional development strategies based on local leading commodities. Most publications focus on industrial symbiosis, resource efficiency, and circular economy mechanisms at the industrial park level, while the spatial and economic integration of local resources into EIP frameworks remains unexplored. This study mapping the intellectual and collaborative landscape of EIP research, this study identifies three dominant thematic clusters—industrial ecology and circular economy, sustainability and resource management, and local commodity-based innovation. The findings highlight an urgent need to link EIP research with territorial and commodity-based sustainability, offering a new perspective on how eco-industrial models can foster localized and inclusive regional development.

**Keywords:** Eco-industrial parks, local commodities, bibliometric analysis, Scopus, VOSviewer, circular economy, industrial symbiosis

## 1. INTRODUCTION

Eco-industrial parks (EIPs) have emerged as innovative models for promoting sustainable industrial development. They leverage industrial symbiosis to optimize resource use by fostering collaborations among businesses within a defined geographical area (Chertow, 2000). These collaborations involve the exchange of materials, energy, and by-products to reduce waste, enhance resource efficiency, and minimize environmental impacts, aligning with global sustainability goals. The EIP aims to create synergies among geographically close factories to work together in reducing waste and by-products by efficiently sharing resources such as information, energy, raw materials, and infrastructure (Liamsanguan et al., 2008; Chertow, 2007; Butturia, 2019).

EIPs are often seen as practical implementations of the circular economy concept, which focuses on creating closed-loop systems that minimize waste and prioritize resource circulation (Ghisellini et al., 2016). Successful examples, such as the Kalundborg Industrial Symbiosis in Denmark, demonstrate the potential for EIPs to significantly reduce greenhouse gas emissions and improve resource recovery (Lombardi & Laybourn, 2012). Over the past decade, there has been a growing

body of literature on EIPs, with researchers examining topics ranging from system optimization to policy and governance frameworks. A bibliometric analysis by Zhang et al. (2022) revealed that the volume of publications on EIPs has increased steadily, particularly in regions like Europe and Asia, where sustainable industrial policies are prioritized.

While much research has focused on the general principles of EIPs, limited attention has been given to the integration of local commodities. These commodities, such as region-specific agricultural by-products or natural resources, provide opportunities for regionally tailored EIP strategies (Zeng et al., 2020). Incorporating local resources can enhance the economic and environmental performance of EIPs, making them more resilient and context-specific.

Bibliometric analysis is a valuable tool for understanding the evolution of research fields and identifying gaps. By using citation data, co-authorship patterns, and keyword analysis, bibliometric studies provide insights into the intellectual structure of research domains (Aria & Cuccurullo, 2017). In the context of EIPs, this method has been used to map research trends and highlight areas for future investigation. Earlier

bibliometric studies, such as those by Yu et al. (2015), primarily focused on industrial symbiosis and system optimization within EIPs. These studies highlighted the importance of knowledge-sharing networks and policy interventions in driving EIP success. However, they often overlooked the role of local commodities, which can serve as critical enablers of sustainable industrial development (Li et al., 2020). Another study by Barrera et al. (2021) provided an overview of EIP research in promoting the economic development of countries.

Putra et al. (2024) conducted a comprehensive literature review that categorized EIP programs based on their evolution, planning, implementation, and evaluation, highlighting the distinct characteristics of EIP programs in China, Japan, and Korea. China's EIPs were featured as centralized industrial infrastructures facilitated by circular economy and environmental policies. Korea's EIPs focused on building industrial symbiosis (IS) networks driven by business model innovation, emphasizing EIP transition. Japan's eco-town program emphasized waste recycling and landfill minimization to promote eco-innovation through environmental technology advancement. All programs were incorporated into national policies and development strategies with specific financial support, incentives, and public-private collaboration schemes, serving as models for global EIP mainstreaming.

Despite these valuable insights, there remains a lack of comprehensive bibliometric analysis that connects eco-industrial parks with local commodities to understand how local resource systems intersect with industrial symbiosis research. Addressing this gap is crucial to reveal emerging trends, influential actors, and intellectual structures that shape this evolving field. Therefore, this study aims to conduct a bibliometric analysis using the Scopus database (2014–2024) and VOSviewer to map research trends, identify collaboration networks, and explore the knowledge structure on EIPs and local commodities. The findings are expected to contribute to a deeper understanding of how localized resource use and industrial symbiosis jointly advance sustainable industrial development.

## 2. MATERIALS AND METHODS

### 2.1 Data Source and Search Strategy

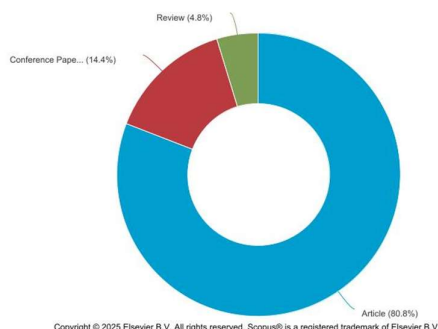


Figure 1. Document by type

Available online at <https://conference.lppm.unila.ac.id/index.php/icsiger>  
DOI: <https://doi.org/10.23960/icsiger>

Data were retrieved from the Scopus database, which provides extensive peer-reviewed coverage across scientific disciplines. The search string used was a total of 1,321 documents were identified from 2014–2024. These included articles (80.8%), conference papers (14.4%), and reviews (4.8%).

### 2.2 Data Analysis and Visualization

Bibliometric analysis was performed using VOSviewer (version 1.6.x) to generate visual maps of: (a) Co-authorship (authors and countries); (b) Citation and source analysis; and (c) Keyword co-occurrence. Descriptive publication data by year, source, country, and subject area were obtained from Scopus' *Analyze Results* tool. Visualizations from VOSviewer were used to identify clusters and thematic evolution.

## 3. RESULTS AND DISCUSSION

### 3.1 Publication Output and Growth Trends

Between 2014 and 2024, publications on *eco-industrial parks* (EIPs) and *local commodities* have shown a steady upward trend (Figure 1). The total output of 1,321 documents demonstrates increasing scholarly attention toward sustainable industrial transformation.

A notable rise occurred after 2018, coinciding with the mainstream adoption of circular economy policies in China, the EU, and the United Nations Sustainable Development Goals (SDGs). The peak years were 2020–2022, reflecting how sustainability and industrial ecology research became central to green recovery policies post-COVID-19.

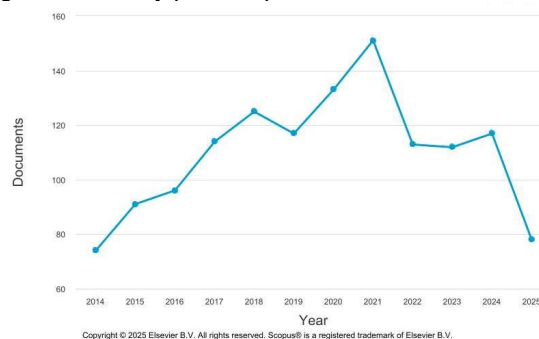


Figure 2. Annual publication trends on *Eco-Industrial Parks and Local Commodities* (2014–2024), Scopus data.

### 3.2 Subject Area Distribution

According to Scopus analysis, the largest proportion of publications (23.1%) belongs to Environmental Sciences, followed by Social Sciences (12.1%), Engineering (11.0%), and Energy (10.9%). This interdisciplinary distribution reflects how EIPs function as a nexus of technological innovation, environmental management, and economic regional planning.

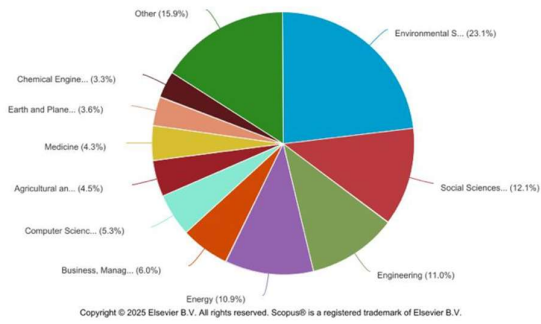


Figure 3. Document by subject area

### 3.3 Leading Authors and Co-authorship Networks

The co-authorship network (Figure 4) shows 10 primary author clusters connected by strong collaboration lines. The most productive and influential authors include El-Halwagi, M.M., Tan, R.R., Chew, I.M.L., and Geng, Y., whose research spans industrial ecology, process engineering, and circular economy policy.

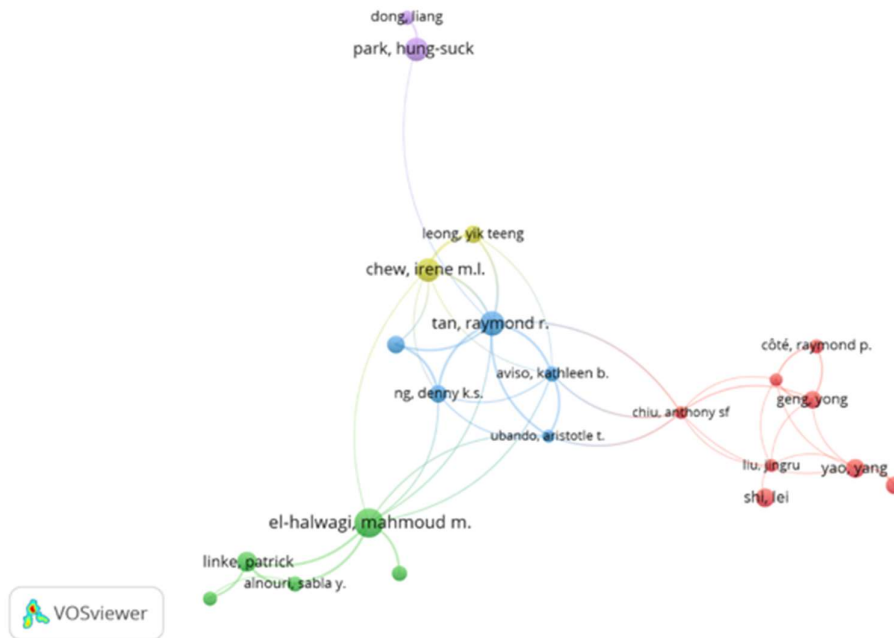


Figure 4. Co-authorship network by authors visualized with VOSviewer (Minimum 5 documents per author).

The provided visualization offering a snapshot of collaborative patterns within a specific, though inferred, academic domain (e.g., Information Systems, E-Learning, or Technology Management). The network is segregated into five distinct color-coded clusters, which represent groups of authors with high frequencies of mutual collaboration.

The overall structure is polycentric, characterized by several strong research groups with varying degrees of interconnectivity. The network highlights the presence of both highly

central, productive authors and more specialized, insular groups, a pattern typical of mature research fields (Akinlolu & Olawale, 2023).

The Green Cluster (Al-Balqaawi F.M) anchored by the largest node, Al-Balqaawi Firdoos M. The size of this node signifies the highest level of productivity (number of documents) and indicates a high degree of centrality within the entire network. This author collaborates closely with Labo A. and Adeyemi M.T. The green group acts as a primary hub, exhibiting a strong connection to the blue cluster, suggesting its research may serve as a foundational or methodological basis for other groups (Marzouk et al., 2023).

Somewhat the Blue Cluster (Yusuf M.M., Khalil N.L.A.) positioned geographically at the nexus of the green, yellow, and red/orange clusters, the blue cluster—featuring authors such as Yusuf M.M., Khalil N.L.A., and Abdulrahman K.A.—functions as a crucial bridging mechanism. The authors in this group are essential for the inter-cluster transfer of knowledge, likely facilitating collaborative projects that span different thematic sub-domains of the research field (Teng et al.,

2024).

Then the Red/Orange Cluster (Osman W.A., Zulkifli Y.) including names like Osman W.A., Zulkifli Y., and Yeoh C.S., exhibits exceptional internal cohesion. The dense lines connecting its members point to robust and enduring localized partnerships, often focusing on a specialized or niche area within the field (e.g., a specific regional context or advanced technical application). Their main link to the rest of the network is through the blue cluster, emphasizing their more specialized, less broadly connected role.

The remaining clusters demonstrate strong intra-cluster collaboration but high inter-cluster isolation. For example the small yellow cluster (Leong K.W., Leong L.) is dense group maintains a tight collaborative focus, predominantly with each other, though it has tenuous links to the blue and green clusters. Similarly, the purple cluster (Zhou Q., Park G.) featuring Zhou Q., Park G., and Yoon S., is highly self-contained, representing a very specialized or potentially geographically isolated research team that focuses intensely on a particular subset of the main field (Anjum et al., 2020).

In summary, the co-authorship network is divided into influential central hubs (green and blue) that drive broader collaborations, and highly cohesive, often specialized, peripheral groups (red/orange, purple, and yellow) that maintain strong internal research agendas. The links between these clusters represent the evolutionary pathways for new collaborative research frontiers.

### 3.4 International Collaboration by Country

The size of each circle, representing a country, is directly proportional to its productivity in the analyzed domain, typically quantified by the total number of documents published. A larger node signifies a greater contribution to the global output of the research field.

The lines connecting the nodes denote a co-authorship relationship. The strength of this link, which often dictates the distance between nodes, is determined by the number of joint publications (co-authored papers) between the two countries. Somehow the nodes are partitioned into distinct clusters, indicated by different colors (e.g., green, red/orange, blue). These clusters represent groups of countries that exhibit higher intensity of collaborative relationships among themselves than with countries in other clusters. This highlights the modularity of the global research landscape.

The visualization immediately highlights a strong, dense, and multi-clustered global research network. The country with the most prominent position is China (labeled in the central green

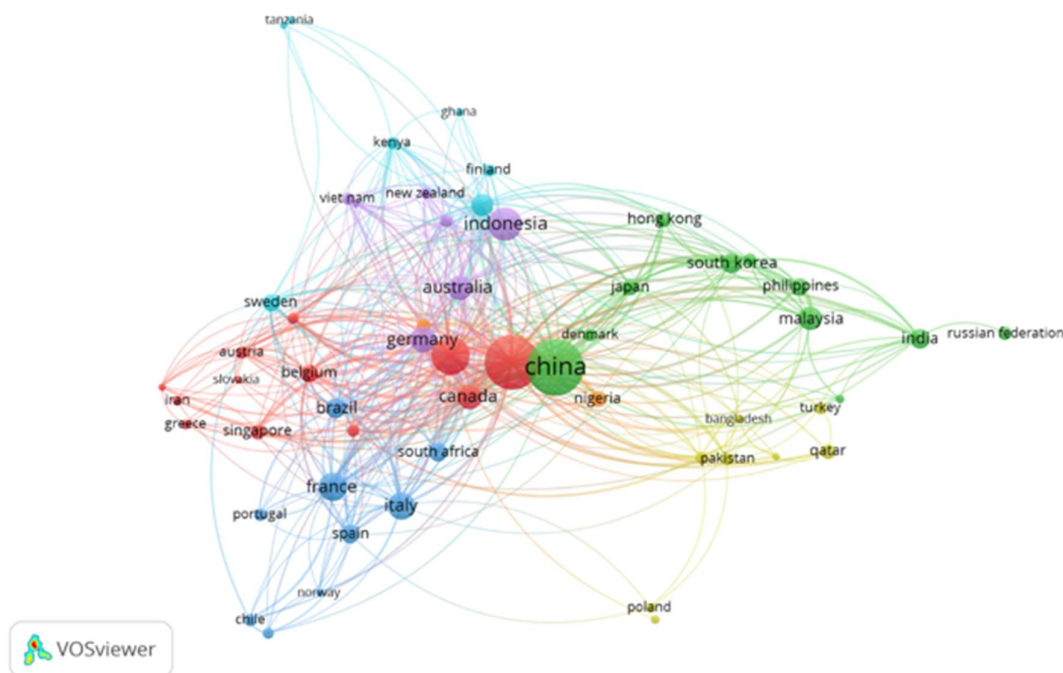


Figure 5. Co-authorship network by country (VOSviewer visualization).

The country collaboration map (Figure 5) reveals that China, United States, United Kingdom, and Indonesia are the top contributors.

This visualization is a core output of bibliometric analysis, designed to reveal the structure and intensity of international collaboration within a specific field of study. The map employs a distance-based visualization technique (Van Eck & Waltman, 2010) where the proximity of two nodes (countries) reflects the strength of their collaborative ties, calculated based on the number of co-authored publications.

cluster). Its node is the largest in the network, confirming its role as the most prolific country and a crucial global collaboration hub in this research area. China dominates with over 400 publications, followed by the USA, UK, and Indonesia. Collaboration patterns show dense interlinks between Asia and Europe, suggesting a strong transnational knowledge exchange network in sustainable industrial research.

The map clearly identifies several major collaborative blocs. The largest clusters include the green cluster (centered around China) and a highly dense red/orange cluster (typically comprising

major Western nations such as the United States and key European countries, although specific labels are small).

The map on Figure 5 also showed inter-cluster collaboration. The links connecting the central green cluster to the surrounding red/orange and blue clusters demonstrate that China acts as a critical bridge for intercontinental scientific exchange. This high degree of interconnectedness across different clusters confirms that international scientific collaboration is a pervasive and essential characteristic of research progression in this field.

### 3.5 Citation Structure and Influential Sources

The network forms a dense, generally circular cluster, suggesting a high degree of interconnectedness and shared foundational knowledge among the highly cited works in this area. Several documents appear very prominent due to their large size (Figure 4), signifying they are the most impactful and frequently referenced papers e.g. Kristensen (2020), Rhodes (2018), Hartley (2020), Shaw (2020), and Jensen (2021).

indicated by author and year). The size of the node is proportional to the number of times that document has been cited within the corpus, indicating its influence or centrality to the field. Highly cited documents include *Chertow (2000)*, *Lombardi & Laybourn (2012)*, *Tan et al. (2016)*, and *Geng & Côté (2019)*. The leading journals are *Journal of Cleaner Production*, *Sustainability (Switzerland)*, and *Journal of Industrial Ecology*, which serve as intellectual anchors for this field. This suggests *Journal of Cleaner Production* is a highly influential, frequently cited, and central publication in this field, likely acting as a core pillar of the research network.

The visualization groups related journals and topics into distinct clusters (represented by different colors and proximity). One major cluster revolves around sustainability science and environmental policy, anchored by journals and terms like *Sustainability Switzerl.* (likely *Sustainability* from MDPI), *environmental science & policy*, and *process integration and optimi.* (optimization).

Another significant cluster includes journals focused on resources, conservation and re.

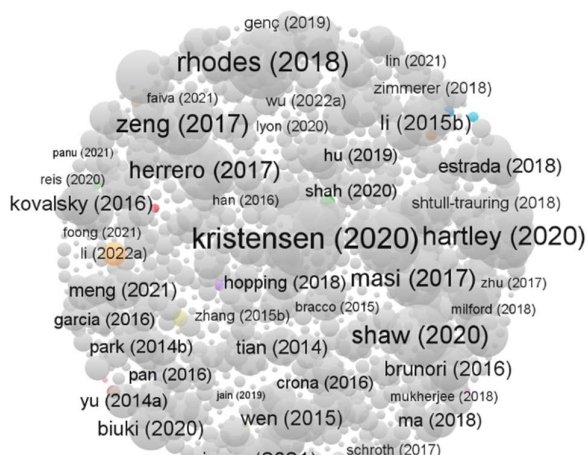


Figure 6 Citation network of most-cited documents in EIP and local commodity research.

These publications likely establish key theoretical frameworks, essential models, or critical empirical evidence related to eco-industrial parks, local commodities, or the intersection of both.

While colors of the nodes indicate the explicit clustering aren't highly visible, the dense grouping indicates that the core research forms a few tightly knit research fronts or schools of thought e.g. papers like Kristensen (2020), Hartley (2020), and Shaw (2020) are positioned near each other, suggesting they are often co-cited, and thus, address similar concepts or build upon each other's work. The presence of recent influential works (e.g., (2020), (2021)) alongside older seminal papers (e.g., Berg (2017)) shows that the field is actively developing while maintaining foundational references.

The visualization of Figure 7 displays a document co-citation network, where each node (circle) represents a highly cited document (usually

(recycling/related), *Journal of Industrial Ecology*, and *environmental science & policy analysis*, suggesting a focus on resource management and industrial ecology.

A third area is positioned around chemical engineering/process and proceedings of the national a. (academy), suggesting a strong link to applied science and engineering aspects.

The proximity of keywords and journals indicates strong thematic connections. For example, the terms *energy & pollution* and *smart innovative system* and are closely associated with *Journal of Cleaner Production*, indicating a high volume of articles in *Journal of Cleaner Production* covering these areas. The term *applied energy* is near *fresh* and other engineering or management journals, showing a diverse application focus.



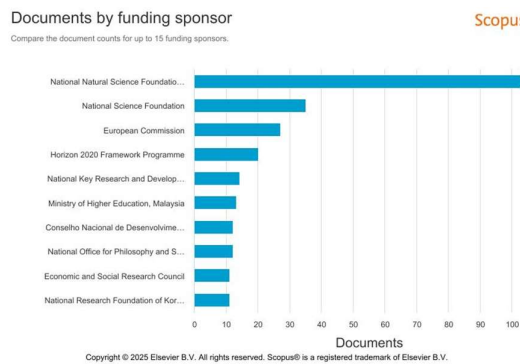


Figure 9. Documents by funding sponsor (Scopus visualization).

The National Natural Science Foundation of China (103 documents) is the top sponsor, followed by the U.S. National Science Foundation (35) and European Commission (27). Leading institutions include Tsinghua University, Chinese Academy of Sciences, Texas A&M University, and De La Salle University, confirming the global diversity and research strength in EIP studies.

### 3.8 Discussion and Interpretation

The bibliometric results show that research on EIPs and local commodities has evolved into a multidimensional domain that integrates technological innovation, governance, and local resource-based sustainability. The growing publication trend after 2018 aligns with the global sustainability agenda and circular economy implementation (Ghisellini et al., 2016).

Chertow (2000) and Lombardi & Laybourn (2012) remain central nodes in the citation network, marking the theoretical roots of industrial symbiosis. The transition toward *quantitative optimization* (El-Halwagi, 2019) and *systemic EIP design* reflects the field's methodological maturity. China's policy-driven approach (Geng & Côté, 2019) dominates, while emerging research in Southeast Asia particularly Indonesia and Malaysia emphasizes the integration of local commodities, confirming Zeng et al. (2020)'s assertion that local resource systems enhance regional resilience.

The results also corroborate Putra et al. (2024), who observed regional diversity: China's centralized approach contrasts with Korea's network-based models and Japan's eco-town initiatives. Our analysis shows that Indonesia's EIP research is increasingly connected to community-based and agro-industrial contexts, marking a new phase of localized sustainability transitions.

However, despite the expansion of EIP studies in various regions, the current bibliometric mapping clearly indicates that no existing study explicitly connects eco-industrial parks with regional development based on local leading commodities. While numerous papers discuss EIPs within the frameworks of industrial symbiosis, circular economy, and waste management, none have directly analyzed how EIPs can serve as

instruments for regional economic transformation driven by local commodity potentials.

This absence is particularly striking in developing regions, where local agricultural, fisheries, and mineral resources form the foundation of regional economies. Yet, EIPs have rarely been conceptualized as territorial innovation ecosystems that harness these resources to achieve circular and inclusive regional growth. This finding represents a significant gap in the global EIP literature and underscores the originality of this study, which bridges the conceptual divide between industrial ecology and regional development through the lens of local resource valorization.

The shift from *industrial symbiosis* (2014–2018) to *regional circularity* (2019–2024) is evident. However, major research gaps persist: (a) Limited empirical analysis of local commodity integration within EIPs; (b) Weak attention to digital transformation (IoT, AI, data analytics); (c) Lack of local policy and governance frameworks for EIPs; (d) Underexplored social inclusion and community participation; (e) Few transnational comparative studies.

Recommendations for Future Research are (a) Develop local circularity indices to assess the economic–ecological impact of local commodities in EIPs; (b) Apply smart technologies (IoT, AI) for monitoring and optimizing symbiosis performance; (c) Conduct policy practice comparative studies across countries; (d) Explore social innovation models for inclusive EIP governance; (d) Strengthen Asia–Europe–Global South collaborations to share best practices.

This study reinforces the claim of Kristensen & Mosgaard (2020) that the next generation of EIPs must be community-centered, combining industrial efficiency with local development. Thus, EIPs are evolving into territorial innovation systems, embedded in socio-ecological contexts.

## 4. CONCLUSION

This bibliometric analysis examined the intellectual evolution, collaboration networks, and thematic structures of *eco-industrial park* and *local commodity* research (2014–2024). The field demonstrates rapid expansion, dominated by studies on industrial symbiosis, circular economy, and sustainability transitions, with China, the USA, and Indonesia emerging as key contributors.

Crucially, this study identifies a major research gap: no existing study explicitly connects eco-industrial parks with regional development strategies based on local leading commodities. Although EIPs are recognized as tools for resource efficiency and environmental management, their role as *drivers of regional development* particularly in leveraging the economic potential of local resources remains unexplored.

Bridging this gap requires an interdisciplinary framework combining industrial ecology, regional economics, and spatial planning.

Future research should focus on: (a) Developing EIP models anchored in local commodity systems (e.g., agriculture, fisheries, and natural resources) to enhance regional competitiveness and resilience; (b) Integrating digital transformation technologies (IoT, AI, big data) for real-time symbiosis management and optimization; (c) Establishing policy mechanisms and local governance frameworks that align national sustainability goals with regional economic priorities; (d) Conducting comparative and empirical studies across diverse regional contexts to validate locally adapted EIP approaches.

In conclusion, this study contributes a novel perspective by positioning *eco-industrial parks* not merely as clusters of sustainable industries, but as strategic platforms for regional development rooted in local commodity potentials. This paradigm offers a new direction for future scholarship and policy innovation—linking industrial sustainability with place-based economic transformation toward an inclusive and circular future.

## Bibliography

- Akinlolu & Olawale, 2023: Akinlolu, O. A., & Olawale, D. A. (2023). Structural characteristics of co-authorship networks: Centrality and connectivity. *Journal of Informetrics*, 17(3), 101412.
- Anjum et al., 2020: Anjum, F., Khan, M. I., & Ahmad, S. (2020). Analysis of co-authorship networks in emerging research domains. *Journal of Academic Librarianship*, 46(2), 102148.
- Aria, M., & Cuccurullo, C. (2017). *Bibliometrix: An R-tool for comprehensive science mapping analysis*. *Journal of Informetrics*, 11(4), 959–975.
- Barrera, E., et al. (2021). *Eco-industrial park research and economic growth*. *Sustainability*, 13(8), 4569.
- Butturia, G. (2019). *Resource sharing and symbiosis in eco-industrial networks*. *Journal of Cleaner Production*, 225, 1072–1084.
- Chertow, M. (2000). *Industrial symbiosis: Literature and taxonomy*. *Annual Review of Energy and the Environment*, 25, 313–337.
- Geng, Y., & Côté, R. (2019). *Industrial ecology and circular economy transitions in China*. *Journal of Industrial Ecology*, 23(1), 1–12.
- Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). *A review on circular economy: The expected transition to a sustainable future*. *Journal of Cleaner Production*, 114, 11–32.
- Kristensen, H. S., & Mosgaard, M. A. (2020). *A review of micro-level indicators for circular economy transition*. *Journal of Cleaner Production*, 245, 118–123.
- Li, H., et al. (2020). *Local commodities and circular symbiosis: Expanding the EIP framework*. *Resources, Conservation & Recycling*, 162, 105–113.
- Lombardi, D. R., & Laybourn, P. (2012). *Kalundborg and the circular economy*. *Environmental Science & Policy*, 15(1), 15–25.
- Marzouk et al., 2023: Marzouk, M., Hassan, O., & El-Sayed, T. (2023). Mapping scientific collaboration: A bibliometric analysis using VOSviewer. *Scientometrics*, 128(5), 3201–3220.
- Perianes-Rodriguez, A., Waltman, L., & Van Eck, N. J. (2016). Constructing bibliometric networks: A comparison between full and fractional counting. *Journal of Informetrics*, 10(4), 1178–1195.
- Putra, A. N., et al. (2024). *Comparative analysis of EIP evolution in China, Japan, and Korea*. *Environmental Management Review*, 32(2), 187–202.
- Teng et al., 2024: Teng, W., Lee, H., & Chen, J. (2024). Bridging silos: Inter-cluster collaboration patterns in computational research. *Research Policy*, 53(1), 104921.
- Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523–538.
- Yu, C., Davis, C., & Dyer, M. (2015). *Bibliometric trends in industrial symbiosis*. *Resources, Conservation and Recycling*, 99, 52–60.
- Zeng, Y., et al. (2020). *Integrating local resources into eco-industrial parks*. *Sustainability*, 12(6), 2445.
- Zhang, X., et al. (2022). *Global research trends in eco-industrial parks: A bibliometric overview*. *Journal of Cleaner Production*, 365, 132786.