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Scientific Mapping of Research on Performance of Industrial Strategies in the Face of Environmental and Materials Challenges in Morocco

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Abstract

This article examines the relationships between the performance of industrial strategies, environmental management, and materials management in Morocco. The objective is to map the scientific dynamics at the intersection of these dimensions and to identify emerging trends and gaps. The literature review highlights rapid growth in research on industrial sustainability, marked, however, by disciplinary fragmentation and the still marginal integration of materials as a strategic variable. The central problem lies in the lack of a unified analytical framework to articulate innovation, productive performance, and ecological transition in transition economies. To address this issue, the study employs a bibliometric methodology, based on the extraction of data from Scopus for the period 2020–2025, using a targeted query that encompasses the fields of economics, environment, energy, and materials. The results reveal a structuring of the field still under construction, limited collaborations, and a weak representation of the themes of circularity and ecodesign. A future research perspective would consist of developing integrated models combining bibliometric data, sectoral indicators and case studies to assess more precisely how industrial strategies concretely influence the ecological transition in emerging economies.

1. Introduction

The rapid evolution of environmental and industrial challenges in Morocco is leading to a gradual redefinition of national economic priorities. Under growing pressures related to sustainability, decision-makers are now being called upon to rethink the strategic performance of industries in light of ecological criteria (Gallab *et al.*, 2021). This transformation requires an integrated approach, where innovation, the circular economy, and eco-design are combined to achieve sustainable efficiency and long-term value creation (El Hamdi *et al.*, 2020).

1.1 Background

The most recent research demonstrates a profound conceptual shift in the relationship between industrial performance and environmental sustainability. This shift now goes beyond the corrective or compensatory logic to which the literature has long accustomed us. This shift is not simply a mechanical response to regulatory pressure or the climate emergency; it reflects, in a subtler way, a

transformation of the epistemological framework within which industrial strategy is framed (Hanine and Dinar, 2024; Dahchour *et al.*, 2021). It is no longer a matter of juxtaposing sustainability with performance imperatives, but of making it a structuring, even founding, principle of the very design of production systems (Chetioui *et al.*, 2024).

In this reconfiguration, materials cease to be mere physical, neutral, or interchangeable inputs. They are becoming highly strategic variables, whose properties, whether traceability, recyclability, or even criticality in international markets, directly influence the economic and environmental viability of value chains (Asada *et al.*, 2020; Karki *et al.*, 2025). This awareness, increasingly present in contemporary research, opens up a new analytical space, where material innovation is considered as a lever for industrial regeneration, particularly through the frameworks of the circular economy and systemic ecodesign (Bocken *et al.*, 2016). This theoretical shift is not purely speculative: it materializes in concrete, increasingly complex trade-offs between operational efficiency, ecological cost, and sustainable value creation. The most advanced contributions in this field currently employ hybrid methods, combining life cycle modeling, prospective techno-economic analyses, and composite performance indicators (Hauschild *et al.*, 2018). This use of integrated quantitative approaches reflects a desire to equip strategic decision-making in the face of multidimensional, often conflicting constraints. The figure below illustrates a diagram of the link between the performance of industrial strategies and the field of environment and materials.

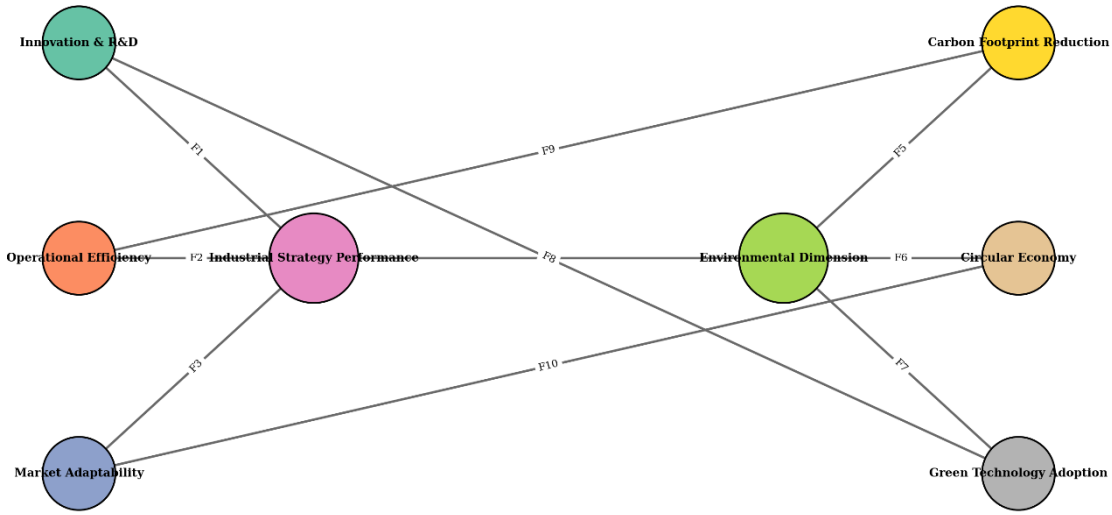

Figure 1. Interconnection between industrial strategy performance and environmental and materials dimensions

The proposed diagram **(Figure 1)** aims to illustrate the structural interdependencies between the performance of industrial strategies and environmental and material dimensions, highlighting the central role played by strategic performance **(F2)** in this architecture. Positioned as the pivotal node of the system, this performance is directly influenced by three fundamental organizational levers: innovation and research and development **(F1),** operational efficiency **(F3),** and market adaptability **(F4).** These three components, representing the internal axes of industrial competitiveness, act in a convergent manner. When coherently articulated, they strengthen the robustness and agility of the production system while laying the foundations for overall industrial performance. This performance, however, is not an end in itself: it functions as a strategic link towards sustainability objectives, materialized in the diagram by flow **F7**. Here, it acts as a transition vector, activating environmental dimensions at the systemic level. These are divided into three major orientations: the circular economy

(F6), carbon footprint reduction **(F4),** and the adoption of green technologies **(F5).** This triptych reflects the evolution of industrial priorities towards objective ecological goals, in response to normative pressures but also to the imperatives of responsible innovation. Beyond this sequential relationship, the visualization highlights the existence of transversal flows **(F9, F10),** which reinforce the idea that certain organizational capabilities exert a dual influence: both on direct industrial performance and on environmental outcomes. Innovation **(F1),** for example, acts simultaneously as a driver of competitiveness and as a lever for reducing carbon emissions **(F9),** while adaptability **(F4)** accelerates the integration of green technologies **(F10).** This network demonstrates that successful industrial strategies are those that successfully combine their internal optimization logic with ecological transformation objectives.

This conceptual modeling, which highlights the dynamic links between internal industrial levers and environmental results, finds a concrete resonance in the sectoral evolution observed in Morocco over the recent period **(Table 1).**

Table 1. The evolution of industrial production indices in Morocco between 2023 and 2024 (from Haut-Commissariat au Plan)

SECTOR	4th quarter 2023	4th quarter 2024	Var %	Year 2023	Year 2024	Var %
Extractive industries	137.6	150.2	9.2	109.1	132.0	21.0
Other extractive industries	138.7	151.9	9.5	109.4	133.4	21.9
Chemical industry	156.0	166.3	6.6	136.0	154.8	13.8
Pharmaceutical industry	143.8	154.7	7.6	143.9	147.5	2.5
Metallurgy	124.8	133.9	7.3	96.8	102.3	5.7
Automotive industry	196.4	202.7	3.2	141.1	157.6	11.7
Production and distribution of electricity	132.4	140.4	6.0	133.9	135.9	1.5

Analysis of sector indices relating to industrial, energy, and mining production (base 100 in 2015) highlights a particularly pronounced growth dynamic over the 2023–2024 period. Several strategic sectors are experiencing significant increases: +21% for extractive industries, +13.8% for chemicals, and +11.7% for the automotive industry. This increase, far from being purely quantitative, can be interpreted as a sign of a concrete activation of the organizational levers identified in the previous conceptual framework, namely innovation, operational efficiency, and the sectors' ability to adapt to changes in the economic and environmental context.

What is worth emphasizing here is that these increases concern precisely sectors historically perceived as among the most resource- or emissions-intensive. In other words, those that would once have been opposed to sustainability logic. However, recent developments tend to reverse this perspective. The chemical industry is exploring and adopting cleaner processes, gradually integrating sustainable inputs; the automotive sector, for its part, is moving toward low-emission technologies, anticipating future regulatory constraints; and extractive industries, finally, are investing in site rehabilitation and circular waste recovery, a sign of a slow but tangible transformation. Therefore, the progress of sectoral indicators not only reflects an increase in production capacity. It also seems to reflect a deeper transformation in the way these sectors view their performance. Performance is no longer thought of solely in terms of volumes or efficiency gains, but is increasingly explicitly aligned with environmental objectives, integrated into growth trajectories. In this sense, the observed data support the idea that, under certain strategic conditions, particularly those relating to innovation, the

reconfiguration of value chains, and resource governance, industrial performance can not only coexist with sustainability objectives, but also constitute a decisive driver for them.

1.2 Research gap

Although recent literature demonstrates a growing interest in aligning industrial strategies with sustainability objectives, it remains dominated by conceptual frameworks developed in industrialized contexts, often detached from the realities specific to emerging economies. This asymmetry raises questions, especially since certain sectoral trajectories observed in countries such as Morocco disrupt this unambiguous narrative. In several material-intensive sectors, we observe a co-occurrence, still insufficiently theorized, between increased production and a shift toward more sustainable practices. These hybrid configurations, which defy traditional typologies, deserve to be examined in greater detail.

More specifically, how levers such as innovation, circularity, and eco-design interact with industrial performance remains largely under-documented, particularly in the French-language literature and in studies applied to North African contexts. There is, in this regard, a form of discrepancy between the global ambition of a green transition and the theoretical and methodological tools used to consider its regional implications. Few studies, for example, use scientometric approaches to map and evaluate the evolution of this field, which lies at the intersection of industrial strategy, materials management, and environmental sustainability.

This deficit, both methodological and geographical, creates a twofold shortcoming. On the one hand, it prevents the emergence of an integrated analytical framework capable of linking companies' internal strategic dynamics to observable environmental outcomes. On the other, it limits the possibility of situating Moroccan industrial transformations in a comparative perspective, both regional and global. In other words, in the absence of such a connection, the contributions of emerging economies to the debate on industrial sustainability risk remain peripheral, even though they could renew the categories of analysis.

1.3 Aim of the study

This study offers a bibliometric analysis of the scientific dynamics that link the performance of industrial strategies to environmental and material issues. It aims to map the main research trends and situate contributions from the Moroccan context within an international academic field that is still being structured. Beyond simply quantifying publications, the ambition is also to provide an integrated reading of the corpus, capable of clarifying how certain industrial sectors manage to articulate productive growth and ecological transition. This work is thus part of a dual logic: to shed light on recent shifts in scientific discourse on industrial sustainability, while promoting emerging trajectories that are still little theorized in the dominant literature.

2. Methodology

To rigorously address the objectives of this research, we opted for a bibliometric methodology, particularly suited to scientific fields that are still being structured, where corpora still appear interdisciplinary and subject to rapid evolution (Zupic and Čater 2015; Laita *et al.*, 2024; Kachbou *et al.*, 2025). This choice is based on a strong conviction: in such contexts, bibliometrics not only allows us to circumvent the interpretive biases often inherent in narrative reviews, but also to access a systematic mapping of the dynamics at play, whether in terms of publication trends, author networks,

or even the semantic proximities that silently structure a field of research (Donthu *et al.* 2021). It thus offers an objective, analytical framework capable of making visible configurations that qualitative observation alone would not reveal. As software, we used VosViewer, Bibliometrix and Biblioshiny to carry out this analysis (Aria and Cuccurullo, 2017; Lrhoul *et al.* 2023; Nandiyanto *et al.* 2024; Hammouti *et al.* 2025).

We entered this query into the Scopus search bar, recognized as one of the most reliable and comprehensive bibliographic databases for analyzing scientific production. : *("industrial strategy" OR "business strategy") AND ("sustainability" OR "sustainable development" OR "eco-design" OR "green materials") AND ("performance" OR "environmental performance") AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (AFFILCOUNTRY , "Morocco")) AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "AGRI") OR LIMIT-TO (SUBJAREA , "MATE") OR LIMIT-TO (SUBJAREA , "BIOC") OR LIMIT-TO (SUBJAREA , "CHEM") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "ENER"))*

Refocusing the analysis on the Moroccan case responds to a twofold observation. On the one hand, in recent years, we have observed a gradual rise in national industrial initiatives integrating environmental dimensions, whether through the promotion of circular sectors, the adoption of green production standards, or the transformation of value chains around renewable or low-emission materials. On the other hand, there remains an apparent lack of consolidated work, particularly in the French-language literature, on how these transformations align with major international trends in sustainable strategy research. In this respect, Morocco constitutes a unique vantage point, both peripheral to the dominant academic circuits and a source of hybrid configurations that can renew specific interpretations. The period 2020–2025 was chosen to capture the most recent dynamics, particularly those that emerged in the post-pandemic crisis, a pivotal period marked by a recomposition of industrial priorities (reshoring, energy autonomy, greening of processes) and by a notable acceleration of scientific production on sustainability themes. The query strategy was constructed to cross three central dimensions: industrial strategy, environmental sustainability, and materials management, while limiting the results to publications affiliated with Morocco and relating to disciplines deemed relevant to the subject (economics, management, environment, energy, chemistry, materials, agriculture, etc.). This targeted filtering ensures both the coherence of the corpus and the robustness of the analysis, while allowing for a scientometric examination of how Morocco is positioning itself in the global reconfiguration of industrial models with a sustainable aim.

3. Results

3.1 Structuring indicators of the bibliometric corpus

The conducted bibliometric analysis on a corpus of 380 publications covering the period 2020–2025 highlights a scientific dynamic still in the consolidation phase (**Table 3**). The average annual growth rate, estimated at 26.76%, indicates a notable increase in the field studied; however, this progression remains relatively moderate compared to other emerging fields with strong traction, such as sustainable management or green technologies, whose documented growth frequently exceeds 35%. On a structural level, the low document density (0.387 documents per author) combined with an average rate of 3.66 co-authors per article testifies to a certain degree of collaboration, without however reaching the critical threshold necessary for the emergence of an interconnected scientific ecosystem, as observed in more mature fields (Zupic and Čater, 2015; El Zaatari & Maalouf, 2022; Guerrero & Sjöström, 2024). The marginal proportion of single-authored articles (n = 13) also confirms the

predominance of collaborative work, a phenomenon typical of research addressing complex, cross-disciplinary issues, particularly in strategy or sustainability.

Table 2. Main bibliometric indicators of the analyzed corpus (2020–2025)

MAIN INFORMATION ABOUT DATA	
Timespan	2020-2025
Sources	220
Documents	380
Annual Growth Rate (%)	26.76
Document Average Age	1.75
Average citations per doc	22.23
DOCUMENT CONTENTS	
Keywords Plus (ID)	1183
Author's Keywords (DE)	1211
AUTHORS	
Authors	983
Author Appearances	1392
Authors of single-authored docs	13
AUTHORS COLLABORATION	
Single-authored docs	16
Documents per Author	0.387
Co-Authors per Doc	3.66

Another telling indicator is the high ratio between the number of author keywords (1,211) and the number of documents, reflecting a notable thematic dispersion. This can be interpreted as a sign of a field that is still fragmented, searching for its stabilized theoretical references. This lexical heterogeneity, coupled with a relatively young average age of publications (1.75 years), suggests a literature still under construction, constantly renewing itself, and likely seeking conceptual standardization. Finally, the average of 22.23 citations per article, particularly high given the youth of the corpus, is intriguing. Two hypotheses can be formulated: either this average is driven by an exceptional concentration around a few highly cited publications, or it reflects a genuine academic echo of the subject in various disciplinary communities. A complementary analysis of the distribution of citations by quantile would be relevant here, as recommended by Donthu *et al.* (2021), to distinguish the halo effect from a more widely shared underlying phenomenon.

3.2 Distribution of articles by year

The evolution of publication volume between 2020 and 2025 (**Figure 2**) reflects a contrasting dynamic. The sharp acceleration between 2022 and 2024 appears to mark a moment of heightened scientific interest, likely driven by rising concerns related to the ecological transition and the gradual structuring of the field of sustainable industrial strategy (Donthu *et al.*, 2021; Bakhsh *et al.*, 2024). This surge may also reflect an interdisciplinary appeal, fuelled by regulatory injunctions and renewed managerial expectations. The decline observed in 2025, far from signaling a decline in interest, could instead indicate a shift in the debate toward more specialized, even technical, areas. This type of shift is typical of fields undergoing consolidation, where the initial general interest gradually gives way to more targeted approaches, requiring increased methodological sophistication. In other words, the

downward curve does not necessarily reflect a loss of momentum, but a natural evolution towards more mature and more refined research.

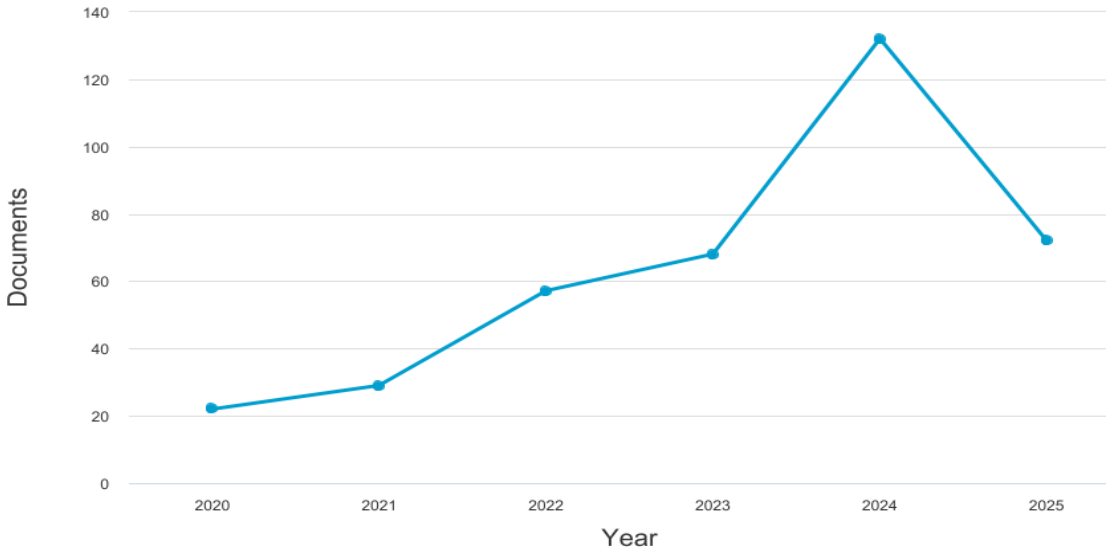

Figure 2. Annual evolution of scientific production (2020–2025) from Scopus

3.3 Distribution of articles by universities in Morocco

The International University of Rabat's dominant position in research on sustainable industrial strategies reveals a strong institutional commitment to these themes (**Figure 3**). However, this concentration also highlights an uneven distribution of scientific capacity at the national level. As in other emerging countries, such centralization can hamper the dynamics of inter-university collaboration, which is essential for structuring a field. The marked gap between institutions suggests a risk of fragmentation, which could hinder the emergence of a coherent research framework around industrial sustainability in Morocco.

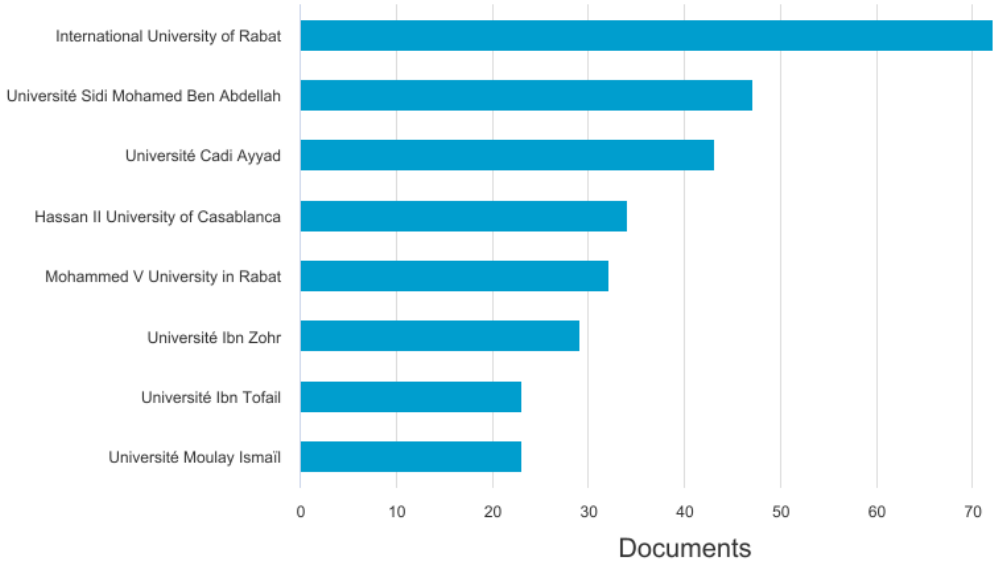

Figure 3. Distribution of publications on sustainable industrial strategies by university affiliation in Morocco (2020–2025) – Top 8 from Scopus

3.4 Documents by authors in Morocco

A cross-analysis of the number of publications, the h-index, and the FWCI highlights an uneven distribution of scientific capital among the most prolific authors. While some, such as Cherrafi (24

documents), stand out for their productive intensity, others, such as Ikram (FWCI of 5.65 for 15 publications), display a much higher weighted impact for a lower volume (**Table 3**). This dissociation between quantity and impact is consistent with the observations of Abramo and D'Angelo (2016), who argue that raw productivity does not necessarily predict adjusted citation reach.

Table 3. Main Moroccan and international authors on sustainable industrial strategies: productivity, impact and citation performance

Name	Documents	h-Index	Field-Weighted Citation Impact
Cherrafi A.	24	23	2.94
Belhadi A.	21	38	5.03
Ikram M.	15	33	5.65
El Baz J.	12	22	2.54
Kamble S.	12	48	5.10
Zekhnini K.	11	11	2.66
Garza-Reyes JA.	10	61	3.16
Bag S.	9	46	4.70

The marked variation in the FWCI (ranging from 2.54 to 5.65) highlights the heterogeneity of publishing trajectories. The case of Zekhnini (FWCI 2.66) illustrates a more moderate positioning despite comparable production, while Belhadi, with a high h-index (38) and an FWCI of 5.03, embodies a double recognition - both sustainable and internationally visible. These contrasts invite us to go beyond volume logic by integrating combined metrics to understand better the diversity of publication strategies and the differentiated quality of the channels used (Harzing and van der Wal, 2009). We will now analyze the co-occurrence between all the authors in our corpus in the following **Figure 4**:

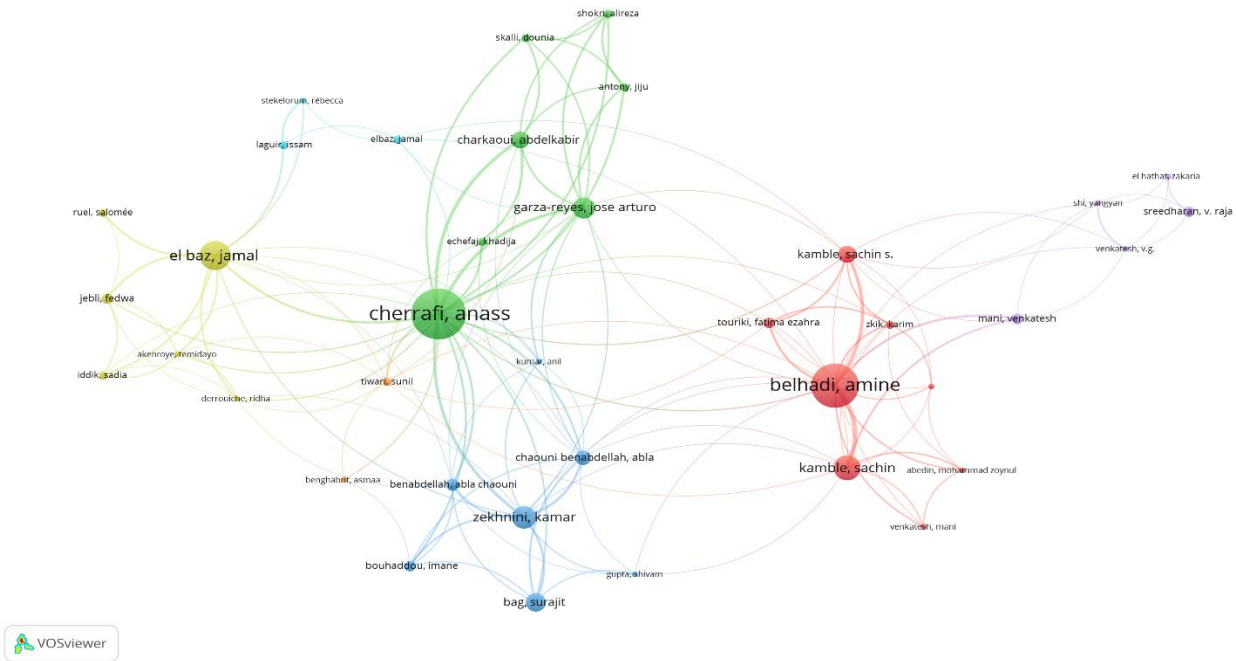

Figure 4. Network of co-authors in publications on sustainable industrial strategies (by VOSviewer)

The co-author graph reveals a structuring into several distinct clusters, testifying to the existence of thematic or institutional sub-communities. This configuration, typical of fields in a consolidation phase, reflects collaborative dynamics centered on cores with strong internal coherence. The density

of certain poles reflects a growing specialization, while the inter-cluster links, still limited but present, suggest a progressive opening towards transversal exchanges. Such a balance between local roots and broader connections is common in interdisciplinary fields in structuring.

The structuring of the field reveals a marked dynamic of specialization, centered around a few highly productive authors. This concentration, typical of phases of disciplinary consolidation, allows for the establishment of solid conceptual foundations, but raises questions about the diversity of the approaches used. The network of co-authors reflects this crystallization, with clusters exhibiting strong internal coherence and still limited cross-disciplinary connections. This configuration, common in emerging interdisciplinary fields, suggests a balance under construction between local anchoring and progressive openness. In other words, behind the apparent polarization, a collaborative architecture in transition is emerging, heralding a broadening of interactions between previously compartmentalized communities.

3.4 Keyword analysis

The hierarchical structuring of keywords highlights conceptual proximities that go well beyond simple lexical affinities. We observe a marked convergence between the themes of strategic planning, innovation and life cycle, reflecting the increasing integration of sustainability logics into environmental analysis frameworks, notably the LCA (**Figure 5**). Furthermore, the rapprochement between performance, circular economy and sustainability suggests a systemic reading where the circular economy becomes a strategic lever for value creation. While the thematic blocks retain a certain autonomy, their growing interconnection reflects a field that is still segmented, but in a process of recomposition. This progressive weaving of technical and strategic concepts reveals the emergence of a shared scientific language at the interface between industrial innovation, sustainability and strategic management.

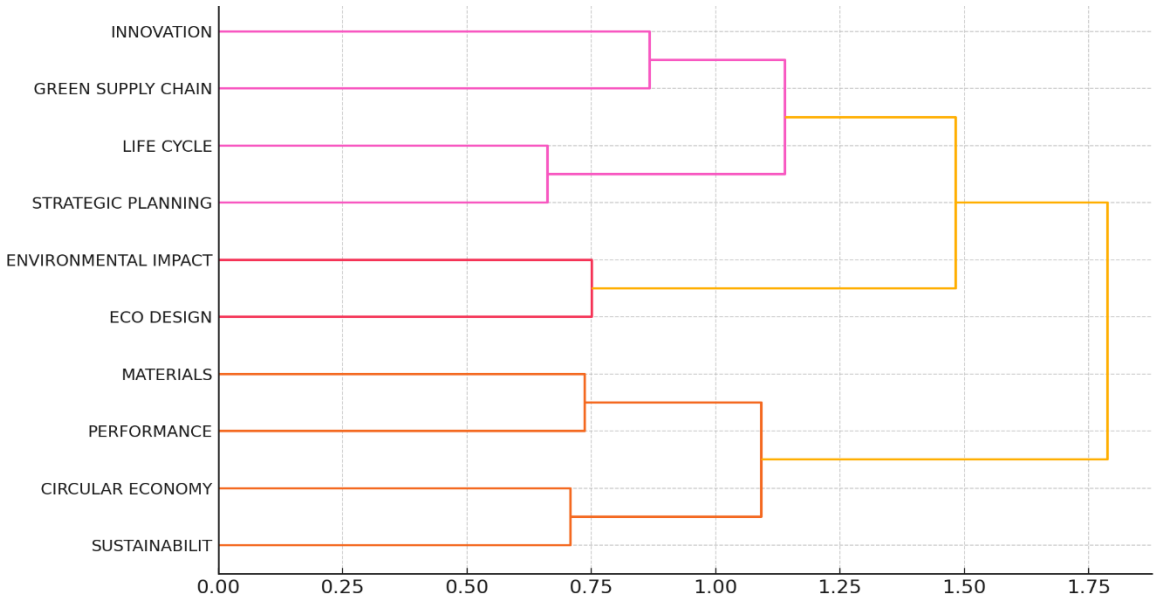

Figure 5. Prioritization of key concepts by co-occurrence: towards a semantic structuring of research

The configuration of the co-occurrence network reveals a field structured around specialized but partially interconnected semantic poles, suggesting a balance between thematic differentiation and increasing integration (**Figure 6**). The dense links between sustainability, circular economy, and decision-making indicate a shift toward more operational approaches to strategic sustainability, typical

of fields in emerging maturity (Zupic and Čater, 2015). The spatial organization of the network also reflects a progressive aggregation of previously dispersed perspectives: themes such as supply chain, environmental performance, or the evaluation of circular policies converge around central nodes. The pivotal position of the term sustainability (largest orange node) thus reflects a reconfiguration of the field toward a more integrated conceptual architecture, in line with contemporary expectations for research with high societal impact (Janik *et al.*, 2021; Chakir *et al.*, 2023; Stival *et al.*, 2025).

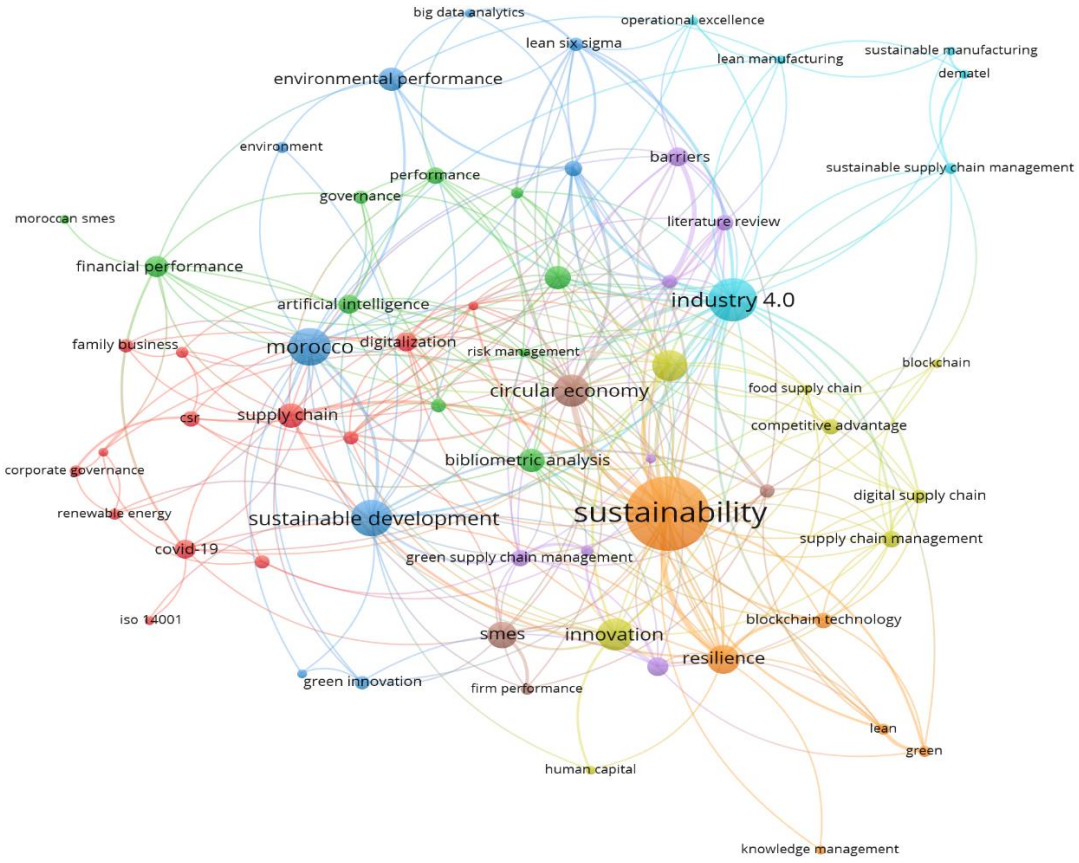

Figure 6. Keyword co-occurrence map (by VOSviewer)

3.4 The Sankey Diagram

The Sankey diagram highlights a structured circulation of scientific concerns across periods, key concepts, and publishing journals (**Figure 7**). It reveals a growing shift toward themes such as the circular economy, sustainability, and Industry 4.0, a sign of a gradual refocusing of research on industrial and environmental transition issues, linked to the dynamics of sustainable strategy and operations management. This evolution appears less linear than multidirectional, reflecting a continuous reconfiguration of scientific priorities as journal editorial guidelines adapt.

Analysis of the flows between keywords and journal titles reveals editorial polarization: some publications, such as the Journal of Cleaner Production and Business Strategy and the Environment, play a central role in hosting work that spans multiple themes, while others specialize more narrowly. This thematic concentration illustrates a double movement: broadening of research objects on the one hand, and refocusing of contributions around journals perceived as reference platforms for work with a substantial interdisciplinary scope.

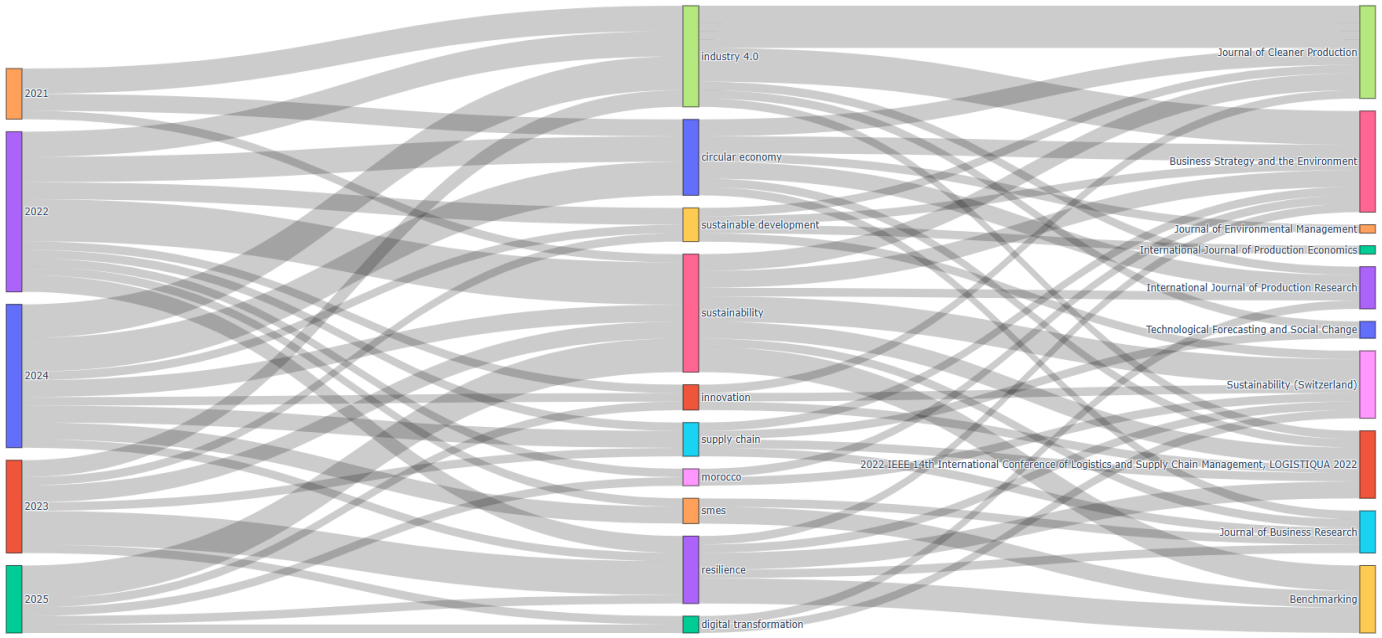

Figure 7. Circulation of scientific priorities in sustainable industrial strategy: from thematic positioning to publication channels

Conclusion

This study highlights a still-marked fragmentation in the scientific landscape dealing with industrial performance and sustainability. While these two concepts are now frequently equated in academic discourse, their actual articulation, particularly concerning materials, remains partial and sometimes even superficial. The bibliometric analysis conducted here reveals a field under tension, where cross-disciplinary approaches struggle to assert themselves in the face of still-rigid disciplinary anchors. The persistent divisions between environmental, economic, and technological approaches reflect, in many ways, a lack of a unifying conceptual framework capable of bringing these dimensions into dialogue coherently and operationally.

In the Moroccan context, this diagnosis resonates particularly strongly. Recent sectoral dynamics, particularly in the extractive, chemical, and automotive industries, indicate a shift toward more sustainable practices. Yet, this transformation, which remains largely empirical, is still poorly captured by the national scientific literature, both in terms of volume and analytical depth. The weak network of local collaborations, coupled with the persistent marginalization of concepts such as ecodesign and circularity in the corpora studied, raises the need for an epistemological repositioning.

In this regard, the bibliometric approach deployed is not limited to a simple mapping exercise: it becomes a critical lever for identifying blind spots, quantifying imbalances, and identifying new research priorities. By refocusing the analysis on the connections between industrial strategy, materials management, and environmental imperatives, it opens the way to a more systemic and potentially more relevant interpretation of sustainable performance in economies in transition.

This study, while providing a structuring insight into the dynamics linking industrial performance and material challenges, presents certain limitations specific to bibliometrics. Reliance on indexed databases, such as Scopus, can exclude unreferenced but relevant works, particularly those from local contexts or published outside mainstream channels. Furthermore, the variable quality of metadata and heterogeneous vocabularies can affect the accuracy of analyses. By nature, bibliometrics does not allow us to capture the depth of content or assess the concrete impact of industrial strategies. It maps trends

but remains blind to field dynamics. Therefore, future research could usefully combine this approach with case studies, longitudinal analyses, or empirical surveys. It would also be relevant to further explore the links between material types, levels of industrialization, and environmental performance, to build explanatory models better anchored in the realities of emerging economies.

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Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

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