Corporate Social Responsibility and Environmental Management

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REVIEW ARTICLE OPEN ACCESS

Deciphering Barriers and Strategies in Environmental Management Accounting (EMA) Adoption: A Comprehensive Two-Decade Analysis

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Received: 24 September 2024 | **Revised:** 13 December 2024 | **Accepted:** 7 January 2025

Funding: The authors received no specific funding for this work.

Keywords: bibliometric analysis | corporate sustainability | Environmental Management Accounting

ABSTRACT

This study presents a comprehensive analysis of the evolution and challenges of Environmental Management Accounting (EMA) adoption across diverse industries and regions over the past two decades. Through a bibliometric analysis, this study categorizes the literature into three distinct periods, each elucidating crucial developments in EMA practices from initial theoretical formulations to their strategic integration with corporate sustainability and circular economy frameworks. The recent period particularly focuses on identifying the multifaceted challenges in EMA adoption, encapsulated in the newly developed "EMA adoption and application issue framework." This framework not only categorizes but also visually represents systemic barriers such as regulatory constraints, organizational and cultural resistance, economic and technical obstacles, and the influence of external market forces. The analysis reveals significant regional disparities in EMA research, with a notable lack of contribution from European Union countries compared to active regions such as Australia, South Africa, and Southeast Asia, suggesting a critical need for strategic interventions to enhance EMA research and practical implementation in the EU. These findings advocate for more robust regulations, enhanced managerial commitment, and international collaboration to improve EMA adoption rates. This study aims to advance the understanding of EMA's implementation challenges and foster dialog among academics, policymakers, and practitioners to overcome these barriers and enhance the integration of EMA into sustainability strategies globally.

1 | Introduction

Environmental degradation represents one of the most urgent and multifaceted challenges of our time, with profound social, economic, and ecological consequences. According to data from the Organisation for Economic Cooperation and Development (OECD), over 90% of the global population was exposed to harmful pollution levels in 2020, contributing to approximately 5.4 million premature deaths. These deaths not only reduce global economic productivity but also place significant strain on healthcare systems, disproportionately affecting emerging markets and developing economies (OECD 2015).

The European Union's Gothenburg Sustainability Strategy (2001) recognized the severity of these challenges, embedding environmental protection as a core pillar alongside economic growth and social cohesion (Camilleri 2015). More recently, regulatory frameworks like the Corporate Sustainability Reporting Directive (CSRD) have increased pressure on businesses to improve the transparency and accountability of their environmental, social, and governance (ESG) impacts (EU 2022). In this context, businesses are called upon to move beyond mere compliance and public declarations of sustainability by integrating social and environmental considerations into their operational models (Oncioiu et al. 2020). However, while

sustainability reporting has gained prominence as a tool for corporate communication, it often falls short of fostering genuine organizational transformation. Many reports focus on superficial disclosures (i.e., greenwashing) rather than addressing the underlying practices that drive sustainability. This misalignment highlights the need for robust internal tools and methodologies that link environmental stewardship with financial decision-making.

Environmental Management Accounting (EMA) addresses these gaps by systematically identifying, measuring, and integrating environmental costs, benefits, and impacts into corporate accounting and management processes (Phan, Baird, and Su 2017). It encompasses advanced techniques such as life-cycle costing, full-cost accounting, and strategic environmental planning (Qian, Hörisch, and Schaltegger 2017). Unlike traditional financial accounting, which often obscures environmental costs or treats them as externalities, EMA internalizes these costs, enabling businesses to make informed decisions that enhance resource efficiency, regulatory compliance, and long-term competitiveness (Jasch 2003). By capturing the full financial implications of environmental actions, EMA provides a bridge between internal performance monitoring and external sustainability reporting, aligning corporate activities with broader sustainable development goals. Despite its potential as a missing link to sustainability EMA remains underutilized and underexplored, both in practice and in academic research. Existing studies have extensively analyzed sustainability reporting as a response to institutional pressures (Contrafatto 2014), yet they have often overlooked the role of EMA as a foundational tool for achieving sustainability (Bartolomeo et al. 2000). Critics, including Gray (2010) and Schaltegger (2017), have pointed out that most academic work on EMA fails to engage with the principles of sustainable development. Even in sustainability-focused research, the integration of EMA with emerging sustainable development frameworks has been minimal. This study seeks to address these critical gaps by exploring the evolution, application, and challenges of EMA in the context of corporate sustainability (Setiawan, Rahmawati, and Santoso 2023). By examining its role in bridging the divide between institutional demands for sustainability and internal corporate practices, this research aims to highlight the transformative potential of EMA (Thottoli 2022). This study aims to build on prior scientific work by proposing a mixed approach intended to investigate the following research questions:

- RQ1: How is EMA evolving in terms of scientific production?
- RQ2: Which countries are most engaged with this topic and what collaborative relationships exist between them?
- RQ3: How are the research themes on EMA structured in the current literature, and which thematic areas emerge as central or underrepresented in the field?
- RQ4: Is there any evidence in case studies that highlights the difficulties of EMA adoption?

The main contributions of this study are threefold. On one hand, it enhances the academic understanding of the current dynamics and evolutionary trends of the EMA, providing an updated data foundation that can serve as a reference for further research. On the other hand, it offers corporate stakeholders and regulators insights into the transformative nature of EMA, which is essential for making corporate sustainability communications more robust and based on the internal data acquired by companies. Ultimately, a reading of the case studies provides insight into the difficulties in adopting and implementing EMA and its implications for companies subject to sustainability standards.

2 | Methods

This study adopts a bibliometric approach to analyze the existing EMA literature. Bibliometric methods are particularly useful in literature reviews for mapping the research field without significant biases that could compromise the interpretation of the analysis (Zupic and Cater 2015). To develop a comprehensive analysis, we first conducted a descriptive analysis to explore the field, followed by EMA mapping through keyword co-occurrence and thematic maps to observe clusters of subtopics addressed and their significance in the field of study (Chebo and Dhliwayo 2024). The analysis protocol is illustrated in Figure 1. The database selected for extracting document data was Scopus, which is the largest, most reliable, and meticulously curated scientific literature database worldwide (Meho and Yang 2007; Schotten et al. 2017).

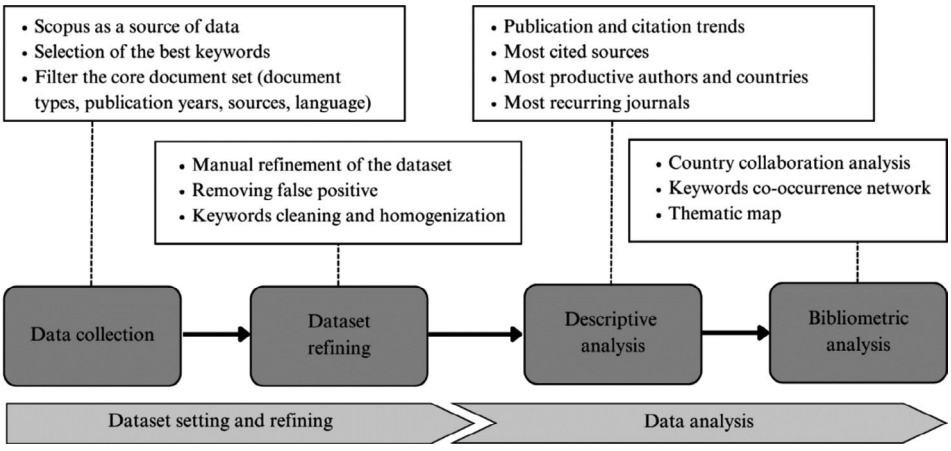

FIGURE 1 | Research protocol (adapted) (Za and Braccini 2017).

The conceptualization of the literature is based on previous knowledge of the topic, which has been expanded through prior reviews of EMA (Guenther, Endrikat, and Guenther 2016; Schaltegger, Gibassier, and Zvezdov 2013; Setiawan, Rahmawati, and Santoso 2023). After a series of tests, the following query was used to search for the documents:

> TITLE-ABS ("environmental management accounting") OR AUTHKEY ("environmental management accounting") AND (LIMIT-TO (LANGUAGE, "English") OR EXCLUDE (LANGUAGE, "Moldavian") OR EXCLUDE (LANGUAGE, "Moldovan") OR EXCLUDE (LANGUAGE, "Romanian")).

All types of documents were considered as the subject of EMA is emerging, excluding reviews and conference papers. A total of 291 documents were identified during the initial selection. The dataset was first cleaned before proceeding with the data analysis phase. Through this process, 20 false positives were removed, reducing the number of documents from 291 to 271. Subsequently, the keywords were standardized, for instance, using only singular or plural forms, or merging keywords with the same meaning, acronyms, or combinations thereof. Consequently, all keywords indicating the same topic were replaced with a single word. Table 1 shows the standardization of the most recurrent keywords.

The same principle was applied to standardize the author names listed with one or more initials. To effectively develop the review, R (using the bibliometrix package) and VosViewer were used as analytical tools.

To further elucidate the practical challenges of adopting EMA, we systematically selected case studies and experimental papers from the dataset. These documents provide valuable insights into the difficulties organizations encounter when implementing EMA, offering a comprehensive view of barriers and facilitating factors in diverse business contexts. This targeted analysis contributes to the identification of specific issues and successes encountered in the field, thereby enhancing our understanding of EMA's application in real-world scenarios.

3 | Main Findings

3.1 | Publication by Year

As depicted in Figure 2, the initial publications on EMA emerged at the dawn of the new century. Irregular growth in the number of publications was observable over the first 15 years, with peaks occurring in 2006 (15 publications) and 2012 (17 publications). Since 2018, however, EMA has secured a stable position within the scientific context, exhibiting more rapid and less erratic growth; 2020 and 2023 saw the highest number of publications, with 34 and 30 papers, respectively. Notably, 53% of the papers were published from 2019 to 2024 (still ongoing), whereas the remaining 47% were disseminated over a span of 19 years (2000–2018).

3.2 | Most Cited Sources

Analysis of the most cited papers provides insights into which studies have had the most significant impact in the

TABLE 1 | Refined set of most recurrent keywords.

Original keywords	Revised keywords
competitive advantage	competitive advantages
competitive advantages	
environmental management accounting (ema)	environmental management accounting
environmental management accounting ema	
ema	
full cost accounting	full-cost accounting
full-cost accounting	
institutional pressure	institutional pressures
institutional pressures	
material cost flow accounting (mfca)	material flow cost accounting
material flow cost accounting (mfca)	
material flow cost accounting(mfca)	
material flow cost accounting	
emas	environmental management accounting system
environmental management accounting system (emas)	
environmental management accounting systems	
environmental management accounting system	

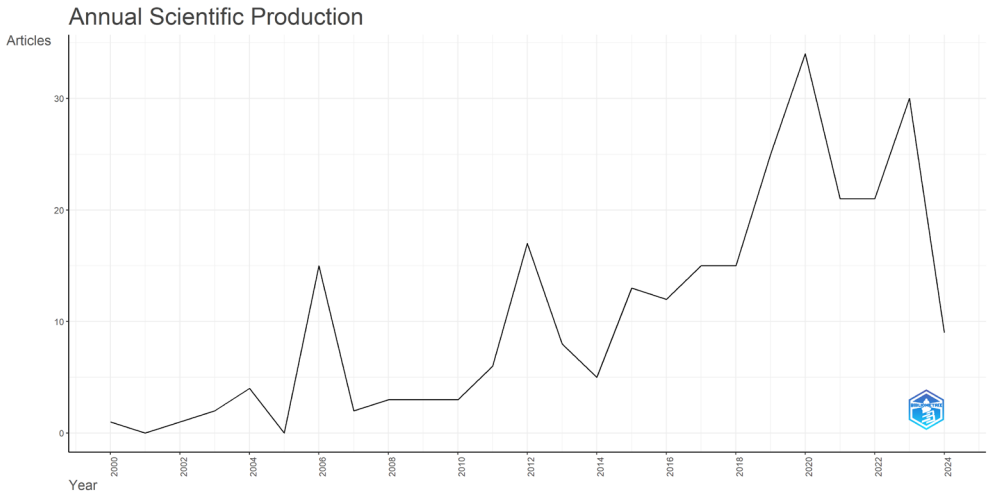

FIGURE 2 | Number of publications per year by 2000.

TABLE 2 | Most cited papers.

Paper	Total citations	TC per year
Latan H, 2018, J Clean Prod	313	44.71
Burritt RL, 2002, Aust Account Rev	281	12.22
Schaltegger S, 2012, J Clean Prod-A	220	16.92
Ferreira A, 2010, Account Audit Account J	211	14.07
Jasch C, 2003, J Clean Prod	182	8.27
Bartolomeo M, 2000, Eur Acc Rev	174	6.96
Henri J-F, 2008, J Environ Manage	156	9.18
Qian W, 2011, Account Audit Account J	150	10.71
Christ KL, 2013, J Clean Prod	138	11.50
Burritt RL, 2006, J Clean Prod	136	7.16

scientific literature. One notable finding is the diversity of EMA applications, ranging from carbon accounting (Schaltegger and Csutora 2012) to waste management (Qian, Burritt, and Monroe 2011), as well as a trend in case studies and empirical analyses (Burritt and Saka 2006; Henri and Journeault 2008; Jasch 2003). As highlighted in Table 2, the most cited paper was by Latan et al. (2018), who examined the effect of combining corporate environmental strategy, top management commitment, and environmental uncertainty, focusing on the role of EMA in corporate environmental performance. The empirical evidence from this study demonstrates that these organizational resources have a positive and significant influence on the use of EMA, which in turn can enhance the environmental performance of companies (Latan et al. 2018).

Other authors have focused on correlational relationships between EMA and other figures or processes. Specifically, Burritt, Hahn, and Schaltegger (2002) concentrated on the relationship between EMA and business actors, developing a framework that categorizes two main components of EMA: monetary environmental management accounting (MEMA) and physical environmental management accounting (PEMA) (Burritt, Hahn, and Schaltegger 2002). Others have explored the relationship between EMA and innovation, finding a positive association between EMA and product innovation but not with process innovation (Ferreira, Moulang, and Hendro 2010). Most studies are still attempting to map the field, its boundaries, and its limitations; however, it appears that research is still far from developing operational processes that could enable the transformation of internal processes in the business context.

3.3 | Most Productive Countries and Authors

Table 3 displays the 10 authors with the highest number of publications. It is evident that there is a disparity in the number of publications between Burritt R.L., Schaltegger, and the rest of the authors, with the first two accounting for 35 out of a total of 82 articles, representing 42.68% of the publications.

An unexpected finding is the absence of major European countries, apart from Germany, from the top five most productive countries in terms of the number of publications. This situation is anomalous considering that the European Union is among the most active organizations, with a dense agenda in terms of sustainability and eco-sustainable economic development (Mammadov et al. 2024). The list is dominated by publication numbers in descending order: Malaysia (24), Australia (23), South Africa (17), Indonesia (15), and Germany (15). In contrast, European countries not only have fewer publications but also lack multiple-country production (MCP), indicating a high degree of isolation from the centrality of the topic (Figure 3).

3.4 | Journal's Publishing Activities

Table 4 presents the ranking of leading journals based on the volume of publications, including the number of papers, Scimago Journal and Country Rank Rating (SJR Rating), H-index, and field of study.

The *Journal of Cleaner Production* (JClePro) was undoubtedly the most prolific, with 36.36% of the publications in the top 10. Specifically, JClePro publishes a robust mix of theoretical and technical articles on EMA. The articles range from those with a theoretical focus, exploring frameworks and models of sustainability and environmental management, to more technical pieces discussing practical implementation, specific tools such as Material Flow Cost Accounting (MFCA), and case studies on industrial applications.

TABLE 3 | Most productive authors.

Author	Articles	Articles fractionalized
Burritt RL	20	8.75
Schaltegger S	15	5.62
Christ Kl	7	3.67
van der Poll HM	7	3.17
Jasch C	6	4.70
Lee K-H	6	3.67
Viere T	6	1.75
Zvezdov D	6	2.03
Gibassier D	5	3.83
Doorasamy M	4	3.00

3.5 | Country Collaboration Analysis

The analysis of international collaborations in EMA studies reveals a surprising absence of interactions among EU countries, despite the emphasis placed by the European Green Deal on environmental research (García-Sánchez et al. 2023). Germany has emerged as the only EU member actively involved in international collaborations in the EMA. This observation raises questions regarding the coherence of the EU's environmental research strategies, especially when the EMA plays a crucial role in integrating corporate sustainability practices, which are vital for achieving climate neutrality by 2050 (Figure 4).

3.6 | Author's Keywords Co-Occurrence

An analysis of the connections among the most frequently discussed topics within the dataset can provide further insights into state-of-the-art scientific research on EMA. We began with the 50 most frequently used keywords by the authors to create the keyword co-occurrence network, as shown in Figure 5.

Four main clusters were identified, based on their connections.

- The blue cluster focuses on EMA, key theories, institutional pressures, and their relationship with financial performance.
- The green cluster concentrates on principal techniques employed by researchers, such as MFCA, activity-based costing, and life-cycle costing.
- The purple and red clusters center on environmental costs, cost accounting, and decision-making processes.
- The sky blue cluster represents environmental performance, energy efficiency, and process innovation.

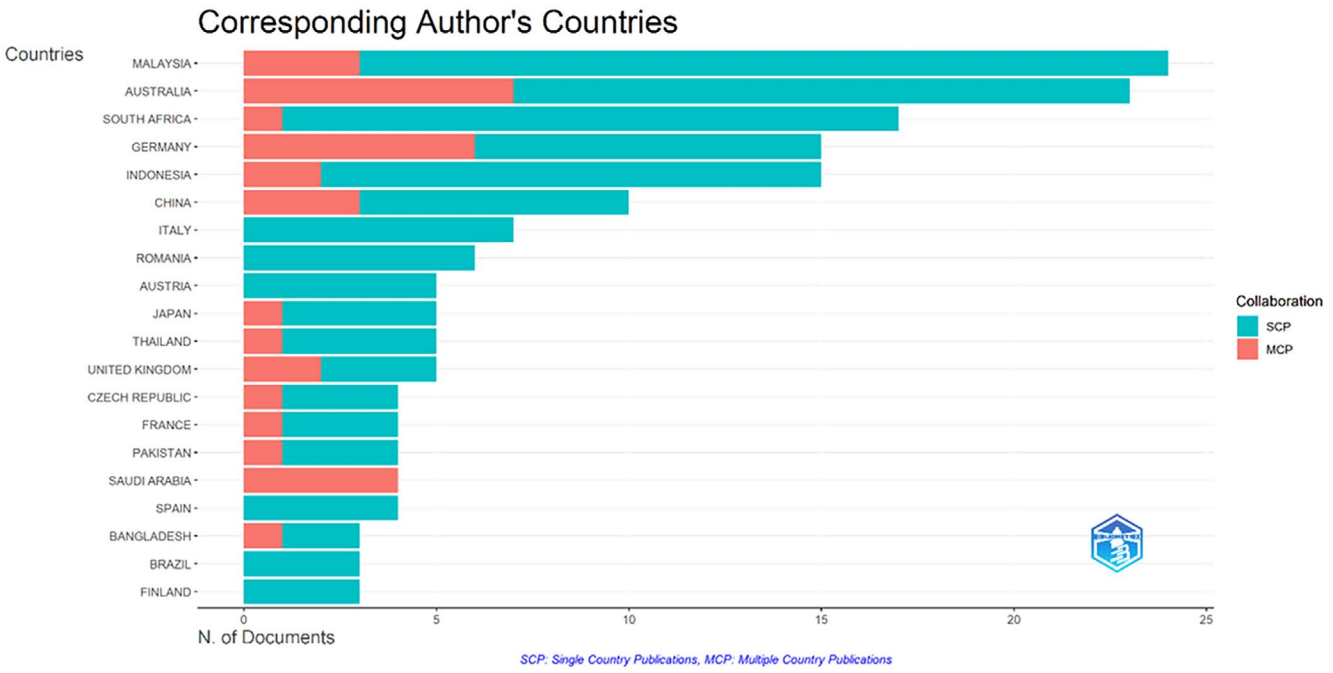

FIGURE 3 | Corresponding author's countries.

TABLE 4 | Most recurring journals.

Journal	No. of papers	SJR rating	H-index	Field of studies
Journal of Cleaner Production	36	2.058	309	Business, Management and Accounting
International Journal of Energy Economics and Policy	14	0.310	53	Economics, Econometrics and Finance
Sustainability	13	0.672	169	Computer Science
Accounting, Auditing and Accountability Journal	8	1.847	121	Business, Management and Accounting
Business Strategy and the Environment	6	3.666	147	Business, Management and Accounting
Journal of Accounting and Organizational Change	6	0.583	34	Business, Management and Accounting
Cogent Business and Management	5	0.567	44	Business, Management and Accounting
Environmental Economics	4	0.407	7	Economics, Econometrics and Finance
Journal of Environmental Accounting and Management	4	0.197	15	Business, Management and Accounting
Journal of Environmental Management	3	1.771	243	Environmental Science

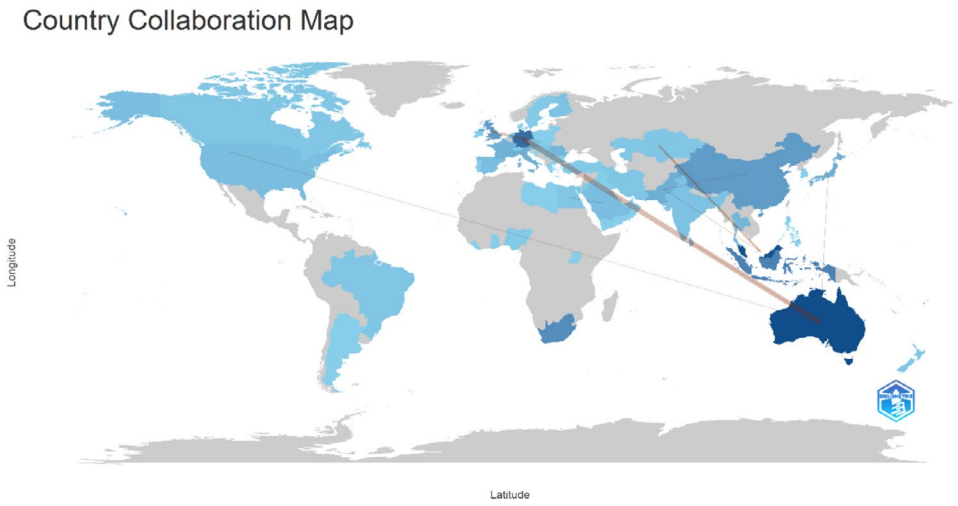

FIGURE 4 | Countries' collaboration world map.

3.7 | Thematic Map

We developed a thematic map (Cobo et al. 2011; Tennekes 2018) that visualizes clusters of keywords and their connections within the dataset. These clusters were analyzed by calculating two parameters: "density," which measures the intensity of internal connections within a cluster, and "centrality," which indicates the significance of a cluster's external connections within the field of study. The results are organized into a strategic diagram with four quadrants.

1. Top right quadrant (1): Themes that are well-established and central in the field.
2. Top left quadrant (2): Themes that are well-developed but marginally important.
3. Bottom left quadrant (3): Marginal and less-consolidated themes potentially emerging or declining.
4. Bottom right quadrant (4): Relevant themes that are still in development.

The thematic map shows that most of the clusters are in quadrants two and four, indicating specialized themes that are either in development or of marginal interest in the field.

The thematic map shows a predominance of clusters in the second and fourth quadrants. Specifically, the basic themes, which are relevant but still developing, relate to general concepts, such as financial performance, institutional pressures, the EMA itself, and, more broadly, environmental strategy. On the other hand, in the second quadrant, we can observe several niche themes such

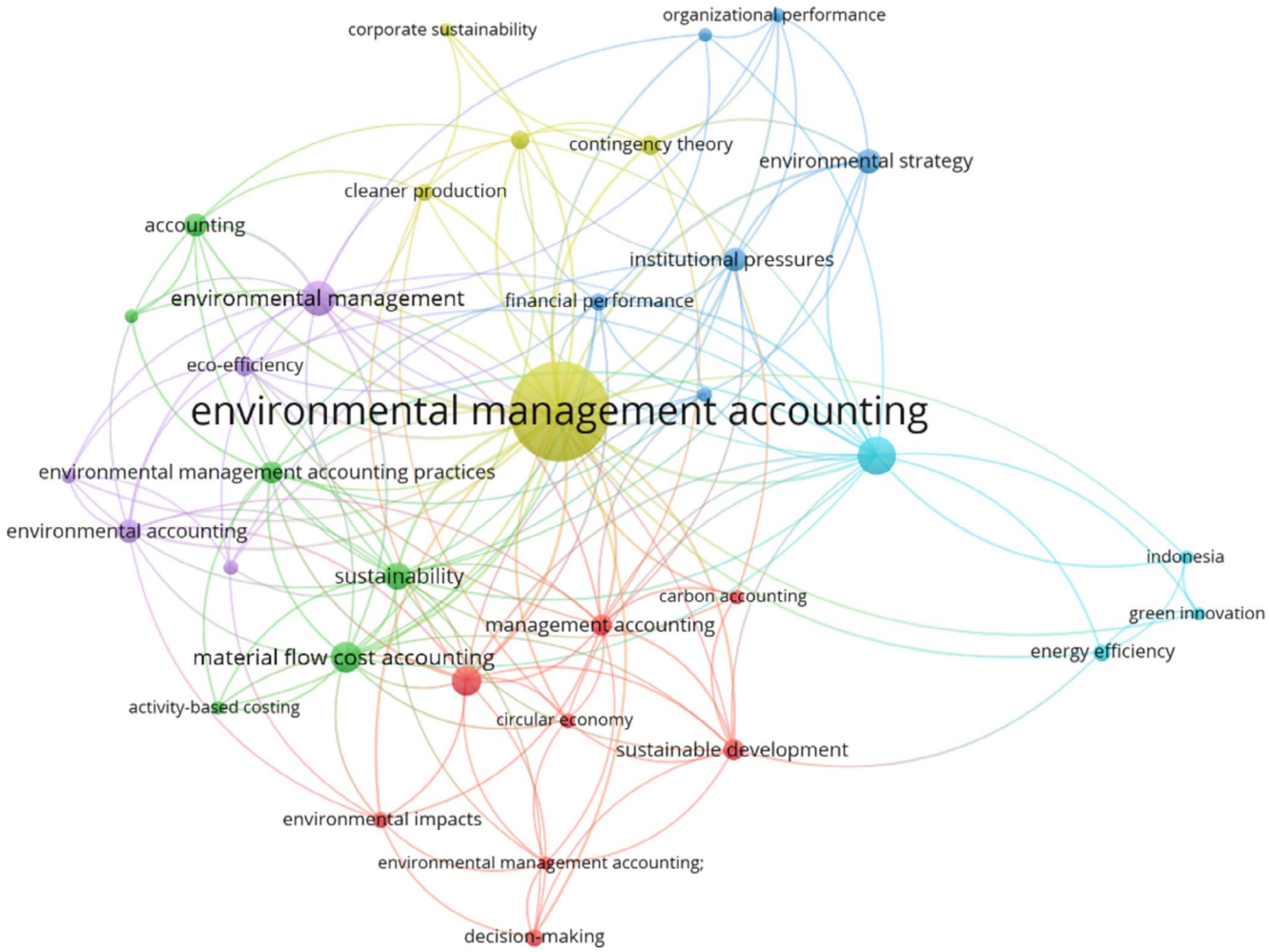

FIGURE 5 | Authors' keywords co-occurrences.

as carbon accounting, corporate environmental ethics, process innovation, and climate change. There is a notable absence of well-established and central themes in the first quadrant where clusters related to Environmental Management Accounting Practices (EMAs) and Environmental Management Systems (EMS) can be found. Delving deeper, this cluster is composed of the following keywords: "EMAs" (13), "EMS" (5), "manufacturing" (5), "performance" (4), "developing economy" (3), "information systems" (3), and "structural equation modeling" (3).

3.8 | Case Study Analysis

This section examines studies that identify the challenges in adopting EMA systems. By analyzing studies from various industries and regions, we aim to highlight common themes in EMA adoption difficulties. These insights will aid managers, policymakers, and researchers in overcoming these barriers to promote broader implementation of EMA across sectors (Table 5).

3.8.1 | Regulatory and Institutional Challenges

The adoption of EMA is impeded by numerous regulatory and institutional challenges, which vary significantly according to the geographic region and organizational size. A primary obstacle is the absence of coercive pressure; in many areas, particularly in developing countries, regulations lack the stringency necessary to compel organizations to implement EMA practices. This situation is exacerbated by the weakness or absence of enforcement mechanisms (Susilowati et al. 2023), rendering the adoption of EMA less urgent. This is evidenced by findings demonstrating how the relationship between coercive pressures and EMA adoption varies according to company size (Elhossade, Abdo, and Mas'ud 2021), indicating that responses to pressures depend on specific circumstances and company characteristics.

Institutional support in both developing and developed countries is insufficient to promote and facilitate the adoption of EMA practices, resulting in slow adoption rates and reduced compliance levels (van der Poll 2022). Furthermore, the recurrence of inconsistent or entirely absent mandates across different jurisdictions affects organizations' motivation to adopt EMA, perceiving it as voluntary or secondary to legal compliance (Debnath 2016; Kumalawati et al. 2023).

Environmental regulations are often fragmented and vary considerably between countries and regions, leading to inconsistent adoption of EMA practices, which can discourage

TABLE 5 | Case studies selected.

Authors	Year	Journal
Alnaim M., Metwally A.B.M.	2024	*Sustainability (Switzerland)*
Nguyen T.H.	2022	*Cogent Business and Management*
Lutfi A., Alqudah H., Alrawad M., Alshira'h A.F., Alshirah M.H., Almaiah M.A., Alsyouf A., Hassan M.F.	2023	*Sustainability (Switzerland)*
Kumalawati L., Sudarma M., Rahman A.F., Iqbal S.	2023	*International Journal of Energy Economics and Policy*
Salim K.M.A., Amir A.M., Maelah R., Jalaludin D.	2023	*International Journal of Business and Society*
Susilowati N., Mahmud A., Widhiastuti R., Santoso A.	2023	*IOP Conference Series: Earth and Environmental Science*
Doan T.N., Nguyen T.A., Vu H.L., Nguyen H.A., Dam H.A., Nguyen T.S.	2023	*Corporate and Business Strategy Review*
van der Poll H.M.	2022	*Sustainable Development*
Che Ku Kassim C.K.H., Adnan N.L., Ali R.	2022	*Journal of Accounting and Organizational Change*
Nyahuna T., Swanepoel M.	2022	*Environmental Economics*
Nyahuna T., Doorasamy M.	2021	*Environmental Economics*
Tran N.H., Hoang T.H., Nguyen T.T.H.	2020	*Journal of Asian Finance, Economics and Business*
Elhossade S.S., Abdo H., Mas'ud A.	2020	*Journal of Financial Reporting and Accounting*
Le T.M.H., Dang L.A., Le T.H.	2020	*Accounting*
Debnath S.	2017	*Corporations and Sustainability: The South Asian Perspective*

multinational organizations from implementing a unified approach to EMA (Hung, Hoang, and Nguyen 2020). Regulatory pressures frequently focus on larger corporations and overlook small and medium-sized enterprises (SMEs), resulting in uneven adoption levels across organizations of different sizes (Nguyen 2022).

3.8.2 | Organizational and Cultural Barriers

The adoption of EMA within organizations encounters significant organizational and cultural barriers that impede its implementation. The primary obstacle is the resistance to change. Organizations frequently exhibit inherent resistance to adopting novel accounting practices focused on environmental impacts because of perceived complexities and uncertainties regarding benefits (Kumalawati et al. 2023; Le, Dang, and Le 2020). This resistance is exacerbated by a lack of strong leadership and commitment from top management, particularly within SMEs, rendering the effective implementation of EMA practices less probable (Lutfi et al. 2023).

EMA is often perceived as a complex initiative that is relevant only within specific contexts, hindering its broader application. This perception contributes to the challenge of managing change and the cultural shift required to embrace EMA (Debnath 2016). Furthermore, the absence of clear benefits and immediate financial returns from implementing EMA can lead to reluctance, particularly among SMEs. This reluctance is frequently attributed to the perceived cost-prohibitive nature of EMA practices when immediate financial returns are not evident (Lutfi et al. 2023; Nyahuna and Doorasamy 2021).

There is also notable difficulty in aligning EMA practices with existing business objectives and strategies. This misalignment can further deter organizations from adopting these practices, as the EMA may not always align effectively with companies' immediate financial and operational goals (Kumalawati et al. 2023; Nyahuna and Swanepoel 2022). Moreover, cultural and behavioral resistance within organizations can constitute a significant barrier, particularly when the benefits of new practices such as EMA are not immediately apparent or necessitate substantial deviations from traditional methods (Nyahuna and Doorasamy 2021). Organizational inertia and management's perceptions and attitudes toward EMA significantly impede its adoption. Awareness and understanding of the benefits of EMA among managers are crucial, but often insufficient, which can obstruct organizational willingness to adopt these practices (Doan et al. 2023).

3.8.3 | Economic and Financial Considerations

The adoption of EMA is significantly influenced by economic and financial considerations, which can act as barriers for many organizations. One of the most substantial barriers is high implementation costs. Both the initial costs and ongoing expenses related to adopting EMA can be significant, posing a particular challenge for SMEs with limited budgets (Doan et al. 2023; Salim et al. 2023). This financial burden

often makes enterprises, especially SMEs, hesitant to implement EMA.

Moreover, setting up EMA practices is resource-intensive and requires significant upfront investment in terms of time and financial resources. This requirement can act as a deterrent, as organizations may be reluctant to allocate substantial resources without clear immediate returns (Kumalawati et al. 2023). The economic benefits of EMA are often unclear or not immediately measurable, exacerbating organizational hesitance. There is a perception that EMA might not directly contribute to traditional financial performance metrics, which can further deter investment in EMA systems (Debnath 2016; Kumalawati et al. 2023).

The complexity of integrating EMA into existing financial and operational systems presents another significant hurdle. Such an integration can be complex and requires substantial changes in internal processes and personnel training. This complexity makes the integration process daunting and resource-intensive, often necessitating modifications to the established procedures and systems (Nyahuna and Doorasamy 2021; Salim et al. 2023). Additionally, managers often perceive a lack of immediate benefits from the EMA, which can reduce the urgency of adopting such systems. The benefits of EMA may not be immediately tangible, which can lead to delays or reluctance in implementing these systems within the organizational structure (Le, Dang, and Le 2020).

3.8.4 | Technical and Knowledge Barriers

The adoption of EMA faces several technical and knowledge barriers that impede its integration within organizations. These barriers encompass the complexity of EMA systems and the significant deficiencies in knowledge and expertise.

1. Complexity of EMA systems
   - *Technical Demands and Complexity*: EMA systems, including methodologies such as MFCA and Environmental Life-Cycle Costing (E-LCC), require significant alterations to financial and operational processes. Beyond traditional accounting adjustments, they necessitate the reevaluation of resources, energy, and waste management. This complexity can lead to a steep learning curve and notable resistance within organizations (Debnath 2016; Doan et al. 2023). The lack of adequate training further hampers its effective adoption and implementation, especially among SMEs (Lutfi et al. 2023).
   - *System Integration Challenges*: Integrating EMA practices into established financial and operational systems often requires specialized software, process redesign, and data collection frameworks. These technical demands render EMA adoption particularly challenging for organizations that rely on traditional systems (Kumalawati et al. 2023; Salim et al. 2023).
2. Insufficient Knowledge and Expertise
   - *Lack of Skills Among Staff*: Many organizations do not possess personnel trained in EMA, creating a significant knowledge gap. This lack of expertise hinders the effective implementation and utilization of EMA practices. The absence of skilled professionals to guide the integration of these methodologies into existing workflows exacerbates this challenge (Hung, Hoang, and Nguyen 2020; Salim et al. 2023).
   - *Training and Educational Gaps*: Implementing EMA requires a significant investment in staff training. Employees must learn to integrate environmental costs into financial reporting, handle new data collection processes, and align EMA with business objectives. These knowledge gaps can hinder adoption, as organizations may lack the resources or motivation for necessary training (Kumalawati et al. 2023; Susilowati et al. 2023).
3. Data Management and Technical Infrastructure
   - *Data Collection and Management*: EMA systems frequently require new processes for gathering and handling environmental data, and challenging companies are unprepared for these operational changes. Conventional accounting systems may lack the capability to monitor environmental costs or material flows, thus requiring new data infrastructure and software enhancements (Kumalawati et al. 2023).
   - *Lack of Appropriate Tools*: The tools and methods for EMA implementation may not always suit specific industrial needs, thereby posing additional barriers. Companies may find it challenging to identify methodologies or software that accurately captures relevant environmental information (Le, Dang, and Le 2020).
4. Perceived Complexity and Uncertainty
   - *Perceived as Overly Complex*: EMA is often perceived as overly complex, particularly by organizations inexperienced with its methods. This view can hinder its adoption, especially if EMA is unrelated to the company's core activities. Additionally, this complexity raises concerns that environmental accounting might necessitate a comprehensive overhaul of traditional systems (Debnath 2016).
   - *Uncertainty of Results*: The uncertainty regarding the financial and operational benefits of EMA complicates its adoption. Companies may hesitate to implement EMA systems if they are uncertain of the tangible improvements they can provide in terms of efficiency, compliance, or cost savings. This is particularly evident in sectors where environmental performance is not a primary driver of competitiveness (Le, Dang, and Le 2020).

3.8.5 | External Pressures and Market Dynamics

The integration of EMA within organizations is significantly influenced by a variety of external pressures and market dynamics, which can vary greatly across different regions and sectors.

1. *Stakeholder Pressure*: Stakeholder pressure, including consumer expectations and legal requirements, significantly drives the adoption of EMA, particularly in regions

where consumers prioritize environmental responsibility. This alignment with market expectations is crucial, because stakeholders such as customers, investors, and governments demand greater transparency and accountability in environmental reporting (Doan et al. 2023; Hung, Hoang, and Nguyen 2020). Additionally, pressures from NGOs and local communities also encourage businesses to adopt environmentally responsible practices, particularly when such activism is prevalent and vocal in demanding improved environmental performance (Che Ku Kassim, Adnan, and Ali 2022). However, in markets where environmental responsibility is less critical, the motivation to adopt EMA diminishes, often resulting in slower adoption rates, especially in developing countries with weaker institutional frameworks (van der Poll 2022).

2. *Competitive Dynamics*: Competitive pressures also play a crucial role, especially in developed markets where mimetic pressures encourage companies to adopt EMA to maintain parity with industry leaders and peers (van der Poll 2022; Salim et al. 2023). Conversely, in developing markets, the absence of competitive penalties for non-adoption means that companies might deprioritize environmental accounting in favor of other immediate business concerns (van der Poll 2022). The alignment of EMA with a company's broader competitive strategy also influences its adoption; firms with a clear environmental strategy are more likely to implement EMA (Nguyen 2022).

3. *Regulatory and Institutional Pressures*: Governments and regulatory bodies exert coercive pressure through legislative and regulatory mandates, compelling companies to adopt EMA, particularly in developed markets with stringent environmental regulations (Che Ku Kassim, Adnan, and Ali 2022; Salim et al. 2023). These pressures are supported by the need to meet standards set by professional bodies and industry norms, which significantly influences EMA adoption to maintain industry legitimacy (Alnaim and Metwally 2024). However, in developing markets, the lack of robust enforcement diminishes the motivation for companies to invest in EMA (van der Poll 2022; Hung, Hoang, and Nguyen 2020).

4. *Industry-Specific Dynamics*: Industries with significant environmental impacts, such as manufacturing, mining, and automobile production, are more likely to face external pressures to adopt EMA because of higher inherent risks and potential regulatory scrutiny (Doan et al. 2023). However, some industries face unique challenges that complicate EMA adoption, requiring tailored frameworks to address specific environmental accounting needs effectively (Debnath 2016).

5. *Global Market Influences*: Global market dynamics, including international trade and competitiveness, often necessitate the adoption of EMA for companies operating internationally or those competing with firms from regions with stricter environmental regulations (Hung, Hoang, and Nguyen 2020). Moreover, pressure from global investors who favor robust environmental management practices can drive companies to adopt EMA to align with the expectations of socially responsible investors (Hung, Hoang, and Nguyen 2020).

4 | Discussion

4.1 | Evolution of Environmental Management Accounting: A Three-Period Analysis (2000–2024)

This analysis highlights key aspects of EMA's role of EMA in EMA over the past two decades. To address RQ1, publications from the last 20 years were divided into three main periods. The first period, 2000–2011, established the foundation of the EMA theme by Burritt, Hahn, and Schaltegger (2002), Ferreira, Moulang, and Hendro (2010), Jasch (2003), and Bartolomeo et al. (2000). These studies explored theoretical frameworks, process innovations, operational practices, and international comparisons. The second period, from 2012 to 2018, focuses on the correlation between corporate strategies, environmental uncertainties, management commitment, and environmental performance, using the EMA. The contributions of Solovida and Latan (2017), Latan et al. (2018), Schaltegger and Csutora (2012), and Christ and Burritt (2013) build on earlier foundations and delve into new organizational and strategic dynamics, highlighting EMA as a mediator between corporate strategies and environmental outcomes. The third period, from 2019 to 2024, shows further evolution in EMA, emphasizing the integration of corporate strategies with sustainability and the circular economy, and considering institutional and financial factors influencing EMA adoption. The studies by Scarpellini et al. (2020), Latif et al. (2020), Aranda-Usón et al. (2019), and Burritt et al. (2019) empirically validated earlier theories and attempted to integrate environmental accounting with strategy and corporate performance. This evolution underscores EMA's transformative role of EMA in fostering a sustainability-oriented culture and impacting reporting policies.

4.2 | Global Perspectives on EMA Research: Identifying Active Regions and Addressing the European Union's Lag

Regarding RQ2, the most active nations on the topic are outside the European Union, including South Africa, Indonesia, Malaysia, and Australia. Australia collaborated with Germany, the only EU country to have external connections. The isolation of other EU countries and their low production of scientific articles suggests that the EU may be lagging EMA research and implementation compared to other regions. This indicates the need for strategic interventions to enhance efforts and international collaboration. Kong et al. (2022) show that in contexts like China, environmental uncertainty and institutional pressures significantly influence EMA adoption. Institutional pressure shapes corporate environmental strategies with management support and perceived benefits moderating these effects. Similarly, Lombardi et al. (2022) demonstrated that the EU Directive on nonfinancial information can transform corporate practices. The low production of scientific articles on EMA may reflect a lack of a coordinated approach and commitment.

4.3 | Advancing Environmental Management Accounting: Implications From Thematic Trends and Future Research Directions

From the thematic map in Figure 6, RQ3 has significant implications for EMA's future study and implementation. Central themes such as EMA practices and EMS are crucial in research and corporate operations, representing the most developed areas that still require further exploration. EMA's dynamic adaptation of the EMA is vital for addressing external challenges, such as climate change (Haddad et al. 2024) and increasing institutional pressures (García-Sánchez et al. 2023). Companies must adapt to new regulatory demands and expectations. EMA practices as internal controls enable companies to become more sustainable, thus enhancing both environmental and financial performance. This transformation is crucial for reliable sustainability reporting, as mandated by EU directives, which demand prior internal changes supported by green transformational leadership (Hanif, Ahmed, and Younas 2023), EMA, and effective EMS. Reporting thus serves as both an outcome and a measure of the effectiveness of sustainability strategies and management's ability to motivate human capital. Themes, such as financial performance and institutional pressures, located in the developmental quadrants of the thematic map indicate that these essential topics need further integration into EMA practices. This suggests that while solid foundations exist, there is substantial potential for innovation in how companies address environmental challenges.

Thematic map analysis revealed notable differences in the research questions among the three primary clusters of articles: niche themes, basic themes, and engine themes. Niche themes focus on the technical aspects of environmental accounting, which are essential for advancing sector-specific knowledge, yet often remain context-specific and need further exploration to be integrated into a broader, strategic perspective.

- Challenges and opportunities in carbon accounting: How can carbon accounting be improved to reduce the impacts of climate change? (Schaltegger and Csutora 2012)
- Integration of carbon accounting in supply chains: How can an eco-control approach enhance the management of carbon emissions? (Lee 2012)
- Influence of institutional pressures: How do regulatory and coercive pressures influence the adoption of environmental accounting? (Jalaludin, Sulaiman, and Nazli Nik Ahmad 2011)

The research questions in the basic themes focus on the general relationships between environmental accounting practices and corporate outcomes. These questions exhibit a higher level of generalization, attempting to connect environmental

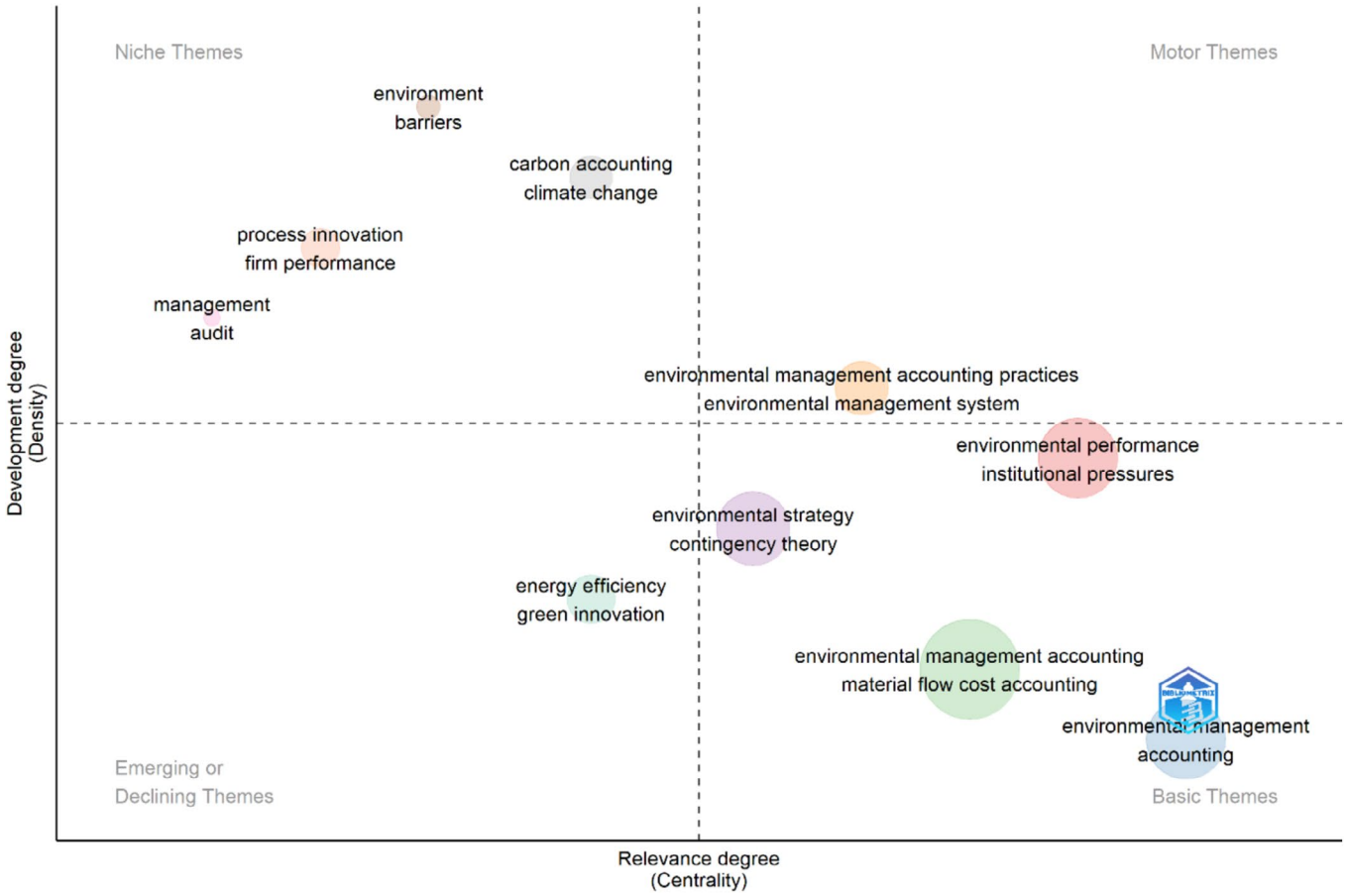

FIGURE 6 | Thematic map.

accounting practices with corporate performance and institutional pressure. The main questions were as follows.

- Effect of environmental strategies on environmental performance: How does the combination of environmental strategies, top management commitment, and environmental uncertainty influence EMA use? (Latan et al. 2018; Solovida and Latan 2017)
- Contingent factors influencing the adoption of EMA: How do corporate characteristics such as organizational size and industry affect the use of EMA? (Christ and Burritt 2013)
- Role of environmental performance indicators (EPIs): How do corporate characteristics influence the measurement and use of EPIs? (Henri and Journeault 2008)

Research questions on engine themes are oriented toward the integration of environmental management practices into corporate systems and the measurement of sustainability. The key questions include the following.

- Integration of Environmental Management Control Systems (EMCS): How can EMCS be integrated into business management systems to enhance sustainability? (Guenther, Endrikat, and Guenther 2016)
- Influence of corporate characteristics on EMA implementation: Which corporate characteristics influence EMA adoption and implementation? (Mokhtar, Jusoh, and Zulkifli 2016)
- Measurement of eco-efficiency: How does environmental planning and EMA influence the measurement of eco-efficiency? (Passetti and Tenucci 2016)

These questions reflect greater complexity and depth, aiming to explore not only specific practices, but also how they can be integrated into an overall corporate system to enhance sustainability and economic performance. The differences in the research questions among the three groups clearly demonstrate that the research is moving toward more strategic and integrated queries. This shift indicates the maturation of the field, in which there has been an effort to integrate specific practices into an overarching corporate strategy that improves both environmental sustainability and economic performance. Nonetheless, although EMA is a growing research trend, further research is required. Future research should focus on the following aspects:

- Development of additional integrated frameworks that link EMA with other business management systems (EMS and EMCS) to promote widespread and effective adoption.
- Analyzing institutional pressures to understand how policies can incentivize the adoption of EMA practices, especially in emerging and developing contexts.
- Strengthening measurement and evaluation tools can demonstrate the benefits of EMA practices in terms of eco-efficiency and business performance.

4.4 | Challenges and Strategic Directions in the Adoption of Environmental Management Accounting (EMA)

The analysis conducted in RQ4 highlights the multifaceted challenges of adopting and applying EMA across various industries and regions. In Figure 7, the EMA adoption and application

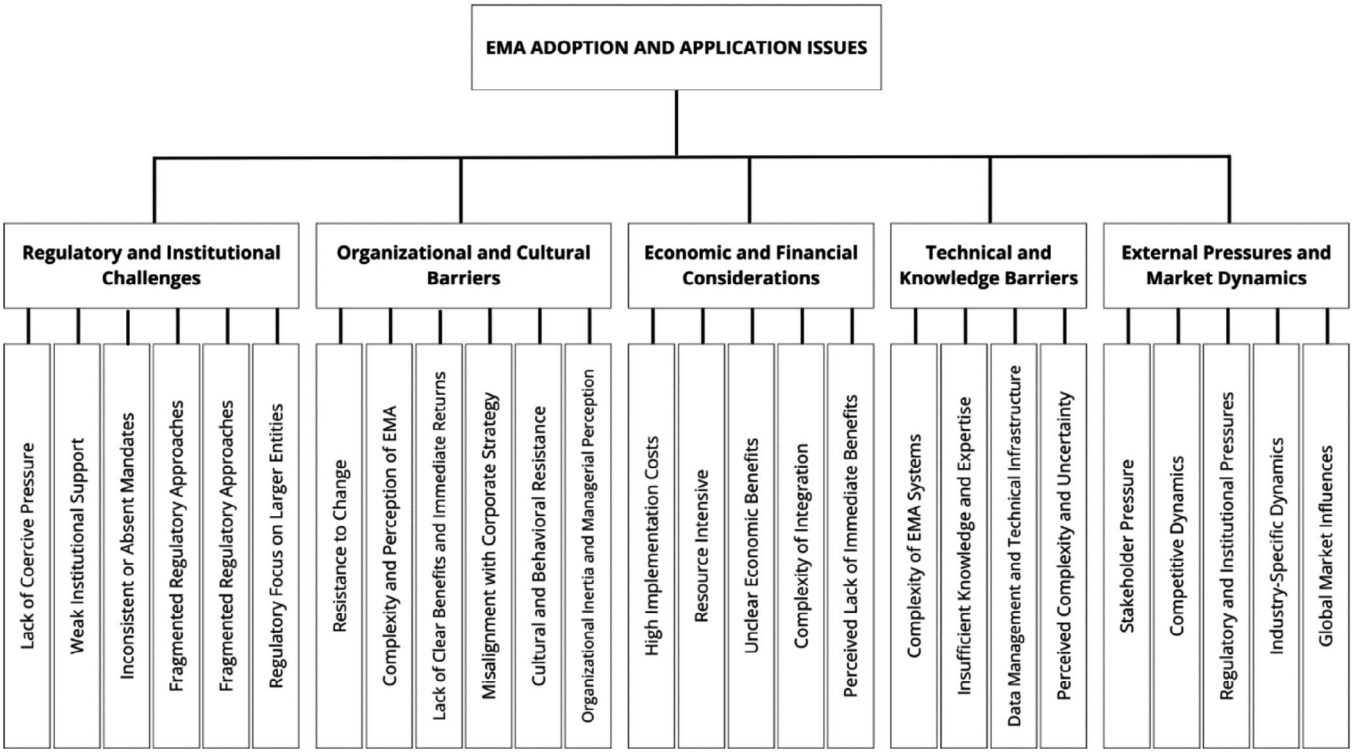

FIGURE 7 | EMA adoption and application issues framework.

issue framework encapsulates these challenges, offering a visual summary that enhances the understanding of the systemic barriers affecting EMA integration. This framework draws on case studies and literature to depict the regulatory, organizational, economic, technical, and market-related hurdles that organizations encounter.

The identified challenges have profound implications for current practices and policymaking. Regulatory and institutional barriers, such as inconsistent mandates and weak enforcement mechanisms, suggest the need for stronger and more uniform regulations across jurisdictions to enhance EMA adoption rates. Organizational and cultural resistance highlights the critical role of leadership and the alignment of EMA with corporate strategies to overcome internal skepticism and integrate EMA practices effectively. Economic and financial constraints underscore the importance of justifying EMA investments by clearly articulating their financial and operational benefits to secure organizational buy-in. Technical and knowledge barriers call attention to the urgent need for specialized training and system integration solutions that facilitate the practical implementation of EMA. Finally, external pressures and competitive dynamics demonstrate the influence of market forces and stakeholder expectations on EMA adoption, which can be leveraged to accelerate compliance and performance improvements across industries.

Regarding the complexities and challenges of adopting and implementing EMA, several key research questions emerge that need to be addressed to advance our understanding and application of these practices. Addressing these questions will be pivotal in refining EMA strategies and methodologies to enhance their viability and effectiveness across diverse organizational contexts.

Key research questions:

- *How can EMA practices be designed to be both cost-effective and resource-intensive while providing the necessary depth of information required for effective environmental management?* This question seeks to explore innovative approaches to refine EMA methodologies that balance financial viability with environmental accountability, particularly benefiting SMEs that face significant financial constraints.
- *What are the most effective strategies to secure organizational buy-in for EMA practices, particularly from the top management? How can these practices be aligned with broader business objectives to ensure a long-term commitment?* This investigation will provide insights into the leadership dynamics and strategic alignments necessary to foster a culture that embraces EMA and enhances its integration into corporate strategies and operations.
- *How do global market dynamics and international regulations influence the adoption and effectiveness of EMA practices, and how can organizations strategically align their EMA practices with these dynamics to maintain competitiveness and compliance?* This study aims to understand the impact of external market forces and regulatory environments on EMA adoption and to identify strategies for firms to effectively navigate these pressures.

For the successful integration of EMA within organizations, leadership at all levels must actively support and engage with EMA practices. Executive and senior management involvement is crucial for the broader acceptance and incorporation of EMA into strategic decisions. This leadership commitment underscores the EMA's organizational priority, facilitating its deeper integration across functional areas.

Clear communication of EMA benefits is essential. Managers must explicitly and persuasively articulate the economic, operational, and reputational advantages of EMA to all stakeholders. Aligning EMA with organizational objectives helps mitigate resistance and fosters a positive perception of EMA investments. Effective communication bridges the gap between EMA practices and perceived value, highlighting their strategic importance beyond regulatory compliance. Addressing knowledge gaps is fundamental for the successful implementation of EMA. Organizations should provide comprehensive training on both technical and strategic aspects of the EMA. Such initiatives enhance employee competencies and foster a culture that values environmental accountability. This approach ensures that EMA becomes integral to daily operations, reflecting a commitment to sustainability. Adopting standardized EMA practices reduces the operational complexity and improves the reliability of environmental data management. Standardization ensures consistent and comparable data across units or regions, enhancing data integrity and decision-making. Managers should advocate for and participate in developing industry-wide EMA standards that meet diverse organizational needs and promote widespread adoption.

Effective EMA integration requires leadership endorsement, strategic communication, comprehensive training, and standardized practices. These elements collectively ensure the alignment of the EMA with organizational goals, enhancing the capacity to address sustainable business challenges.

5 | Conclusion

Over two decades, EMA research has evolved significantly, traversing three developmental phases. The foundational period (2000–2011) laid the groundwork with theoretical models and exploratory studies. This set the stage for the second phase (2012–2018), which examined how EMA supports environmental strategies and improves organizational performance under conditions of uncertainty. The most recent phase (2019–2024) reflects EMA's integration into corporate sustainability, circular economy models, and responses to emerging regulatory frameworks. Despite its global relevance, EMA research reveals stark geographical disparities, with regions like Australia, South Africa, and Southeast Asia leading the way, while the European Union—despite its progressive environmental policies—remains underrepresented.

EMA's transformative potential is evident, serving as a bridge between environmental responsibility, corporate competitiveness, and regulatory compliance. However, the literature is fragmented, lacking cohesive themes, consistent methodologies, and cross-regional insights. Barriers to adoption remain complex and multidimensional, ranging from regulatory and economic

constraints to organizational and market-driven challenges. The EU's limited research contributions underscore a critical misalignment between academic inquiry and policy innovation, leaving untapped opportunities to advance EMA's strategic role in sustainable development.

The review underscores the need to address these gaps and chart new paths forward. Standardized frameworks are essential to improve the replicability of EMA studies and foster global comparability. Investigating the roles of leadership, employee training, and managerial commitment can illuminate the human dynamics driving EMA adoption, while longitudinal studies can reveal its long-term impacts. Additionally, expanding the geographical scope, especially to underrepresented regions and emerging economies, is crucial for a more comprehensive understanding of EMA's global relevance.

Practical applications of EMA must go beyond theoretical discussions. Linking EMA with EMS and EMCS could amplify its organizational impact. Developing cost-effective methodologies tailored to the resource limitations of SMEs can democratize EMA adoption, empowering businesses of all sizes to enhance their environmental performance. Moreover, aligning EMA with institutional pressures and international regulations will strengthen its role in meeting global sustainability standards. To achieve this, policymakers must harmonize regulations, provide targeted incentives, and prioritize the development of tools that demonstrate the tangible benefits of EMA.

EMA holds immense promise as a strategic tool for embedding environmental sustainability into the heart of corporate decision-making. Organizations that embrace EMA can achieve not only improved environmental outcomes and reporting standards but also greater stakeholder trust and competitive resilience. Realizing this potential requires addressing adoption barriers, advancing methodological innovations, and fostering a culture of accountability and innovation. By doing so, EMA can bridge the gap between environmental responsibility and economic performance, driving a transformative shift toward sustainable and resilient business practices worldwide.

Acknowledgments

Open access publishing facilitated by Universita degli Studi Gabriele d'Annunzio Chieti Pescara, as part of the Wiley - CRUI-CARE agreement.

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