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The Role of EMA and Innovation in Achieving Competitive Advantage: A Bibliometric Analysis

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A B S T R A C T

Objective: The alarming climate change situation demands immediate actions to control this situation and organizations must employ environmentally friendly business operations. Organizations are linking environmental concerns with their business objectives to acquire a strong position in the market.

Methodology: This study adopted bibliometric analysis to examine the role of Environmental Management Accounting in gaining a competitive advantage. For this purpose, 475 articles were extracted from the WoS database from 2010 to 2024. In the search bar of the WoS database, the selection of keywords in the first stage was "Environmental Management Accounting" OR "Radical Innovation" AND "competitive advantage" used. After refining the results, the file was extracted and the VOSviewer software was used to conduct a bibliometric analysis of the data.

Results: The findings of this study indicate the different regions that are contributing significantly to this field of knowledge around the globe. The findings also indicate the top authors, journals, and articles that worked in this area of study. The results of this study indicate future research directions and research scholars can consider these directions for their research projects in the future. The result also indicated research themes that are widely used by authors and how these are closely related.

Conclusion: This bibliometric analysis helps to identify the top-cited authors and their works. This study provides in-depth practical solutions to industry practitioners, policymakers, and research scholars.

Keywords: Environmental Management Accounting, Web of Sciences, Radical Innovation, Competitive Advantage.

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1. INTRODUCTION

Environmental Management Accounting (EMA) is the amalgamation of cost accounting and financial accounting to achieve the environmental sustainability goal by reducing the environmental costs, risks, and negative effects on the environment (Appannan *et al*., 2023). There is a need for authentic information that can be employed by organizations to link environmental concerns with business practices (Sands *et al*., 2015). Environmental Management Accounting (EMA) is used to enhance the environmental performance as well as

the financial well-being of organizations by managing the financial and non-financial information of the firm (Latan *et al*., 2018). Radical innovation is employed by organizations to introduce a high level of novelty to cater to more customers and gain a competitive edge in the market (Burritt & Christ, 2016; Ogunode, 2022; Sari *et al*., 2021). Radical Innovation is defined as the transformation from existing practices, processes, products, and services to new, technology-based solutions, processes, products, and business models (West & Boeni, 2023). Radical innovation can be employed to meet environmental sustainability goals by decreasing the excessive consumption of energy and scarce materials to ensure the health as well as safety of nature (Kennedy *et al*., 2017). Radical innovation brings a change in the manufacturing process of organizations to produce products that are more creative and reduce the negative impact of production activities on the environment (Aftab *et al*., 2022; Cillo *et al*., 2019; Nabi *et al*., 2023; Witt & Jackson, 2016). Investing a significant amount in radical innovation is a crucial decision for organizations. However, many organizations fail to improve their market position through this approach (Awan *et al*., 2021; Hoerlsberger, 2019; Kennedy *et al*., 2017). Without proper information and guidelines, employing radical innovation is very risky and costly because organizations rely mostly on new as well as untested technologies. It clashes with the economic as well as financial targets of the organization (Chen & Liu, 2020; Rachinger *et al*., 2019; Severo *et al*., 2017). EMA provides needed information to management and anticipates the outcomes of employing radical innovation. Organizations must create higher value than their competitors to gain a competitive advantage (Jermsittiparsert *et al*., 2020; Negulescu, 2019). Organizations need rare, valuable, and unique resources or capabilities to attain competitive advantage. Competitive advantage is a measure of how efficiently a firm performs compared to its rivals. (Somjai *et al*., 2020). EMA helps organizations achieve a competitive advantage in the industry by ascertaining the emerging threats as well as opportunities and this assists managers in the decision-making process (Ali *et al*., 2023; Singh, 2019). Managers align this information with their goals and environmental protection actions (Ali *et al*., 2021). Environmental management accounting is gaining importance in almost every field, especially in accounting and organizations are moving from traditional accounting practices to this to achieve the vision of a sustainable environment (Awan *et al*., 2021; Chaudhry & Amir, 2020; Karim Suhag *et al*., 2017). EMA provides needed information to management and anticipates the outcomes of employing radical innovation.

Through EMA, organizations convey their efforts to stakeholders by displaying information regarding environmental sustainability, which enhance their market image (Gunarathne & Lee, 2015; Somjai *et al*., 2020; Yuniarti *et al*., 2023). EMA helps organizations to systematically identify, measure, and analyze the environmental costs that are linked with various business operations (Jermsittiparsert *et al*., 2020). Organizations can also measure the financial implications of environmental initiatives through EMA and make efficient decisions to improve the environmental performance of the organizations. Through EMA organizations can make informed decisions related to process optimization, risk management, resource allocation, and improve their competitiveness (Ogunode, 2022).

Despite the significant role of EMA in achieving environmental goals and sustainability targets, the role of EMA in achieving competitive advantage through radical innovation has less empirical evidence. Organizations are applying the latest technology but not all get the desired results (Bennett *et al*., 2022). Many organizations achieve poor or negative results due to inadequate preparation and lack of necessary information to efficiently operate green technology. Research scholars argue that organizations need proper financial support to install the latest technology to mitigate the adverse effects of operational activities. Organizations can increase their environmental performance and financial performance through EMA. However, few studies have explored the role of EMA in achieving environmental goals. This paper aims to identify gaps, the latest trends, and the future direction in the area of study of EMA, radical innovation, and competitive advantage by conducting a bibliometric analysis of the available literature. This paper creates visual representations of

research patterns through maps. These patterns will help researchers deeply understand the role of EMA and radical innovation in achieving competitive advantage and identify future research directions. For this purpose, this paper addressed the following questions:

i. What is the chronological distribution of publications in the realms of EMA, radical innovation, and competitive advantage?
ii. What are the most prominent authors, most frequently used keywords, leading countries, and key collaborations in EMA, radical innovation, and competitive advantage?
iii. What are the future research directions and current practical implications of EMA, radical innovation, and competitive advantage?

2. LITERATURE REVIEW

The adverse conditions of climate change and continuous pressure from different stakeholders on organizations demand massive changes in business activities (West & Boeni, 2023). The government, customers, investors, and other stakeholders are pressurizing organizations to adopt environmentally friendly business activities (Hanaysha *et al*., 2022; Liu *et al*., 2023). Organizations are continuously improving their way of operating and investing heavily in sustainable business practices. The concept of Environmental Management accounting has been emerging for the past two decades in the field of sustainable business practices (Ogbonna *et al*., 2020). The role of EMA in achieving goals of sustainability is remarkable and many research studies concluded that organizations must adopt EMA practices for the smooth functioning of their business operations (Ali *et al*., 2023; Gunarathne & Lee, 2015; Latan *et al*., 2018; Somjai *et al*., 2020). Critical analysts argue that EMA functions to communicate an organization's sustainability efforts to parties. The findings of the research study of Gray (2010) see EMA as a means to boost transparency, accountability, and organizational credibility through auditing and reporting practices. The transparency and communication of an organization's efforts with stakeholders enhance its market reputation. On the side, practical researchers contend that EMA plays a hands-on and problem-solving role in sustainability by supporting managerial decision-making to enhance sustainability performance within organizations (Ferreira *et al*., 2010; Schaltegger *et al*., 2013). Organizations can get a stronger position in the market by improving their environmental sustainability performance. Customers prefer those organizations that adopt environmentally friendly business practices and play their role in mitigating the adverse climate situation (Renaldo *et al*., 2022). EMA provides information that is necessary to link the latest technology with business operations so that organizations can improve their environmental sustainability performance. The research study by Baker *et al*. (2023) highlights the role of EMA in providing information necessary for managerial decision-making processes. The development of tools such as Environmental Management Accounting (EMA) was driven by a focus on sustainable business practices, offering valuable insights for organizational decisions (Burritt *et al*., 2002; Jasch, 2006). While control and accountability aspects of sustainability accounting Organizations bring groundbreaking changes in their business operation through radical innovation often rely on traditional accounting data, strategic decision-making requires a set of environmental information that supports a more practical approach (Baker & Schaltegger, 2015). The improved strategic decision-making capability facilitates organizations to take timely actions to tackle uncertain events and take a lead in the market. Previous studies extensively cover aspects such as the evolution of EMA as a field the adoption of EMA tools and its role, in oversight and competitiveness (Gunarathne & Lee, 2015; Saputra *et al*., 2023).

Through EMA, managers take timely actions and decisions that are necessary to respond to the changing demand of the market regarding sustainable business practices. EMA has significantly evolved over the two decades as both an accounting and managerial tool (Burritt *et al*., 2023). The role of innovation cannot be neglected in achieving the sustainability targets of the organizations. The role of radical innovation in achieving

competitive advantage is highlighted by many research studies (Afraz *et al*., 2021; Farida & Setiawan, 2022; Skordoulis *et al*., 2020). Through radical innovation, organizations bring big changes in their operating activities and this change leads organizations to cater to customers with new and improved products (Aarikka-Stenroos & Lehtimäki, 2014; Engez & Aarikka-Stenroos, 2023; Nabi *et al*., 2022). Radical innovation helps organizations place themselves in the market as pioneer and trendsetters through their latest products. Organizations implement groundbreaking changes in their business operation through radical innovation which strengthens their market position (Shaikh & O'Connor, 2020). The research study by Engez and Aarikka-Stenroos (2023) explained that radical innovation helps organizations to cater to new markets through incremental and optimized business operations. Organizations can get numerous benefits by employing radical innovation and these benefits are highlighted by many research studies (Al-Khatib & Al-ghanem, 2022; Chen *et al*., 2024; Kennedy *et al*., 2017; Souto, 2015). The role of radical innovation in achieving sustainability targets has been less studied. Organizations have increasingly adopted EMA due to its ability to uncover hidden costs and improve eco-efficiency. Organizations can get a stronger market position through improved environmental performance without compromising on their financial gains due to EMA. Despite the growth of EMAs as a decision-making tool in sustainability accounting, limited studies address its role in achieving a strong competitive advantage. The role of EMA in achieving competitive advantage through radical innovation has not been studied before. There are few studies that systematically review the role of EMA in achieving environmental sustainability. Therefore, this research is conducted to perform a bibliometric analysis of the concept of EMA, radical innovation, and their role in achieving competitive advantage. The bibliometric analysis is conducted in this research study to explore these dimensions in detail and highlight the key contributions in the existing literature.

3. METHODS

This study employed a systematic and rigorous approach for the bibliometric analysis technique under the PRISMA guidelines to examine current developments as well as future research directions in the field of study of EMA, radical innovation, and competitive advantage. A multifaceted search strategy was employed using the WoS database to extract data for bibliometric analysis. A thorough screening process was applied to select data for analysis by reviewing the abstracts and assessing the full-text articles. Bibliometric analysis was used to gain quantitative insights into the extensive body of published data on EMA, radical innovation, and competitive advantage. Bibliometric analysis enables researchers to analyze large datasets using mathematical, graphical, and statistical tools (Song *et al*., 2021). It also helps identify prevailing patterns, trends, and future directions within the published data (Bai *et al*., 2021). Key data points from each study, including author information, publication dates, and citation statistics, were collected using a standardized tool to ensure consistency. To address the research questions, co-citation, co-occurrence, co-authorship, and bibliographic coupling analyses were conducted to highlight prominent themes, collaborations, and key contributions. The findings are presented clearly and concisely, supplemented with visual aids to offer a comprehensive overview of the research landscape.

Data Collection Process

The Web of Science database was used to extract data on published articles from 2010 to 2024 in the areas of "Environmental Management Accounting" "Radical Innovation", and "Competitive Advantage". Research articles published from 2010 to 2024 were selected for bibliometric analysis because this period marked the beginning of the decade when there was an increased emphasis on organizations adopting more sustainable business practices. The 14-year time span helped uncover emerging patterns, themes, and broader trends in EMA, radical innovation, and their role in gaining competitive advantage. Further only English-written articles were included because English the primary language of international scientific communication. The English-

written article enhanced the generalizability of findings to broader research contexts. The WoS contains a vast amount of published data, including articles, peer-reviewed papers, book chapters, and other papers, which is why it is a widely used database. Figure **1** represents the sequence of steps followed to collect data from the WoS database. Initially, 1484 articles were identified. These results were then refined by applying filters on the WoS database, to include only publications from 2010 to 2024. Non-English publications were excluded, leaving 475 articles for bibliometric analysis. The ethical consideration in bibliometric analysis is ensured by confirming the quality and validity of the data being used for analysis (Donthu *et al*., 2021). To ensure data accuracy and reliability, we crosschecked the sources. Additionally, we considered various contexts and metrics to screen the records, ensuring data integrity and transparency.

Figure 1. The Process of Data Selection.

Data Analysis

There are many ways to conduct bibliometric analysis. The bibliographic dataset was obtained through the WoS database. The VOSviewer software was used to conduct bibliometric analysis on the extracted file from the WoS database including, co-citation, top citation, co-authorship by country, co-occurrence of keywords, and bibliographic coupling analyses. The co-citation analysis helps to identify the thematic clusters and main themes in EMA, radical innovation, and competitive advantage by highlighting the publications that are frequently co-cited or appear often in the reference list of other articles. Co-occurrence analysis enhances understanding of thematic clusters by identifying the most frequently used keywords. It identifies keywords that frequently appear together across various articles, thus clarifying thematic clusters. Bibliographic coupling analysis identifies interlinked articles, this analysis supposes that two articles are closely connected if these articles have the same references and these articles discuss similar content of interest.

4. RESULTS AND DISCUSSION

Bibliometric analysis highlights significant trends and developments in the areas of research of EMA, radical innovation, and competitive advantage. The analysis reveals a strong link between environmental management accounting and innovation, as well as a significant relationship between radical innovation and a firm competitive advantage. Several studies conclude that radical innovation helps organizations achieve a stronger market position, although it is also a costly and risky endeavor. EMA evaluates the consequences of organizational policies and decisions by providing essential internal and external information to management for making efficient decisions. This analysis identifies a research gap: the role of EMA in achieving competitive advantage through radical innovation has not been studied. There is limited understanding of how organizations use EMA and radical innovation together to gain a market advantage. Similarly, there is a lack

of understanding regarding how radical innovation helps organizations strengthen their market positions. To address these gaps, publications from 2010 to 2024 were thoroughly examined to gain an in-depth understanding of these fields. Figure **2** shows the publication trends for EMA, radical innovation, and competitive advantage from 2010 to 2024. In 2010, there were only 11 publications, and no publications in 2013. After 2013, the number of publications increased, with the highest number being 35 articles published in both 2019 and 2023. In the first five years (2010 to 2015), only 121 out of 475 articles were published. More than 60% of articles were published after 2015, likely due to increasing concerns about climate change and GHG emissions. Governments of several countries impose strict rules and regulations on business organizations to follow certain standards (ISO 14001, ISO 14065, and ISO 50001).

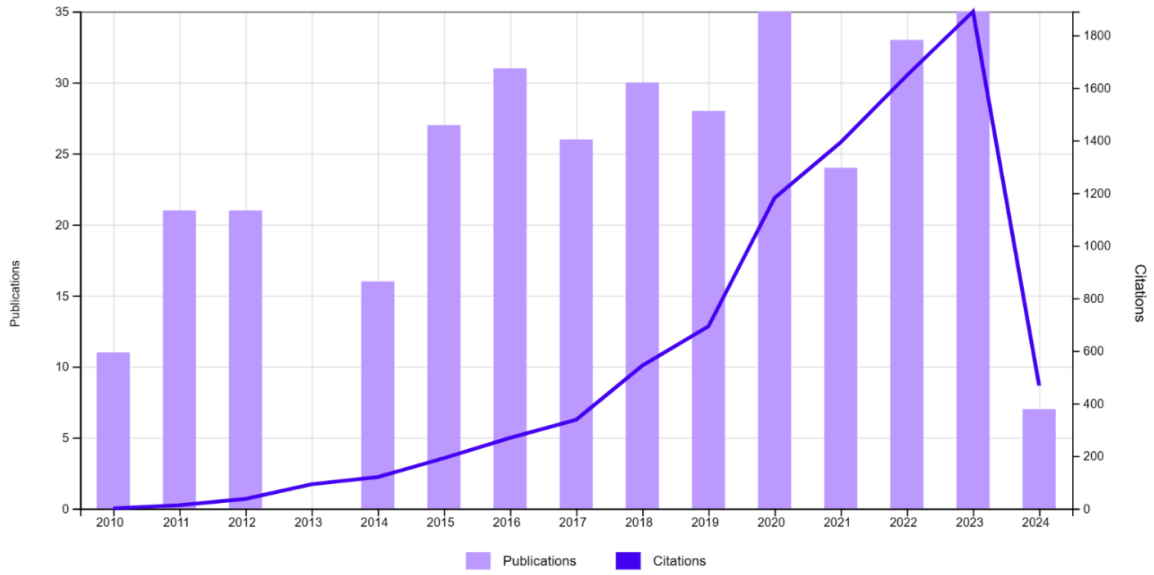

Figure 2. Publication Trend of EMA, Radical Innovation, and Competitive Advantage.

Source: *Web of Science Database*

Keyword Cluster Analysis

Keyword cluster analysis helps to identify key research areas related to the intended research area. Researchers can deeply understand the logical sequence existing in the literature through co-occurrence keyword analysis and identify key research areas through it. It is a visual and analytical technique that helps to visualize the relationships among extracted keywords (Bai *et al*., 2021; Bukar *et al*., 2023). The top 10 most cluster keywords are shown in Table **1** and it facilitates understanding the relationship among keywords.

Table 1. Top 10 Most Frequently Appeared Words.

Ranks	Keywords	Frequency	Total link strength
1	Environmental Management Accounting	112	110
2	Radical Innovation	102	99
3	Competitive Advantage	94	94
4	Performance	82	82
5	Impact	49	49
6	Management	46	46
7	Innovation	44	44
8	Strategy	44	44

9	Sustainability	39	39
10	Dynamic capabilities	34	34

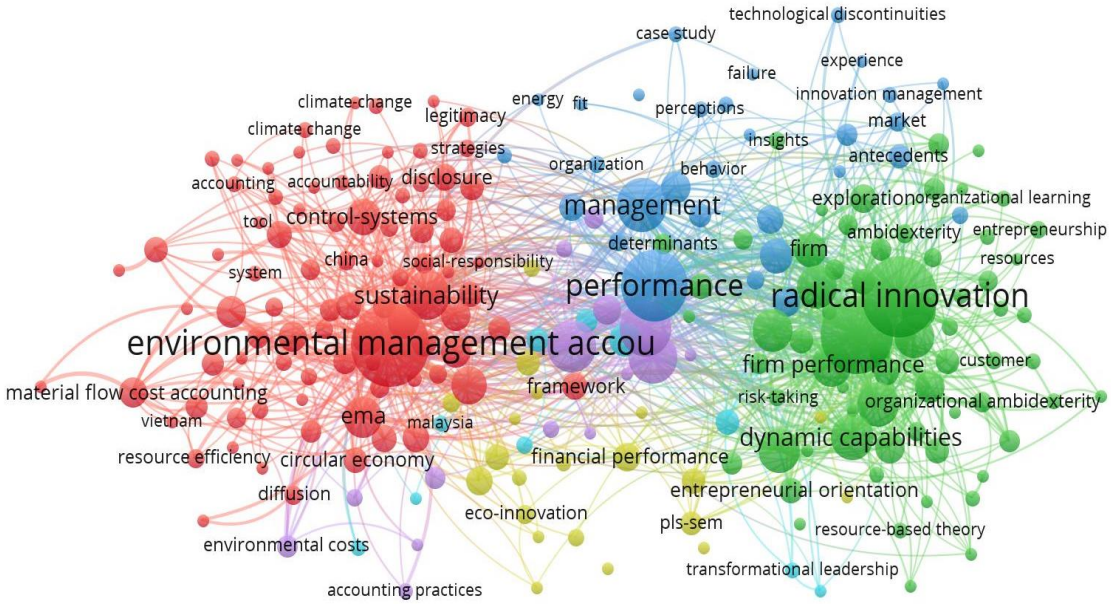

Figure 3. Frequently occurred words.

The co-occurrence network map is shown in Figure **3**, which visually represents the relationship between the most frequent keywords used in 475 articles. As the figure depicts, keywords are represented through a node, and frequency or strength co-occurrence of words is represented through the thickness of the nodes. Many keywords are close to EMA, radical innovation, and competitive advantage, which means that they are often used together, and are much related to these main variables. The remaining keywords may be used alongside and have equal importance related to these key areas.

Co-citation Analysis

Co-citation analysis is a bibliometric technique that is used to recognize those authors that are most frequently cited in a particular area of study. Table **2** shows the top 10 co-cited authors in the area of study of EMA, radical innovation, and competitive advantage. According to the results of the study, Schaltegger, S is the most co-cited author with the highest number of citations 260, and a strength link of 7081 during the period 2010 to 2024.

Table 2. Top Cited Co-authors.

Ranks	Authors	Citations	Total link strength
1	Schaltegger, s	260	7081
2	Burritt, rl	241	6682
3	Jasch, c	131	3315
4	Hair, jf	117	3482
5	Christ, kl	114	3315
6	Qian, w	104	3080
7	Teece, dj	102	3170

8	Gray, r	80	2336
9	Ferreira, a	70	2155
10	Posdsakoff, pm	67	2227

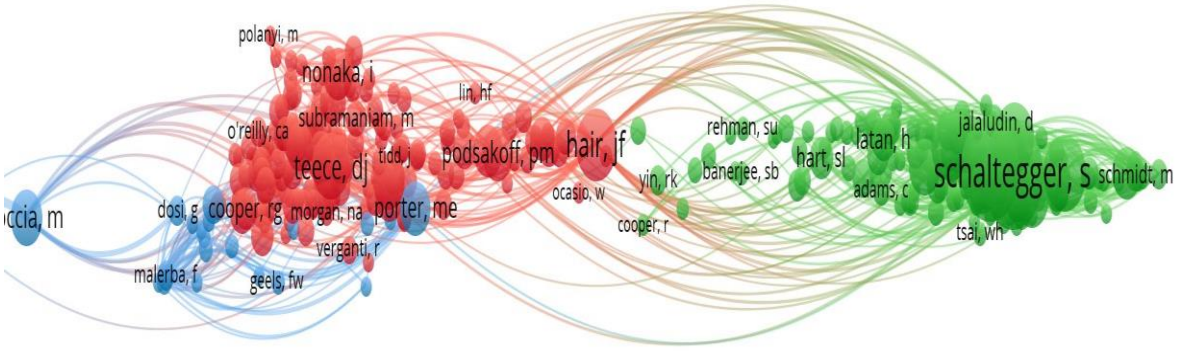

Figure 4. Co-citation Analysis.

Figure **4** shows the relationship between the top 10 authors through a co-citation network map. Different color nodes represent various authors and the thickness of the line indicates the strength of the co-citation analysis. These nodes indicated researchers, which have contributed significantly in the area of EMA, radical innovation, and competitive advantage literature. Through co-citation analysis, researchers can identify key authors who have strong intellectual contributions in the area of the field.

Citation Analysis

The citation analysis helps to identify top-cited documents in the literature. The top cited documents in the field of the study of EMA, radical innovation, and competitive advantage are shown in Table **3**. These top 10 cited documents are extracted through the WoS database. Latan (2018) explores the role of Environmental Management Accounting (EMA) in achieving sustainability goals and he developed a scale to measure EMA. Ferreira *et al*. (2010) also explained the role of EMA in achieving organizational environmental targets. Qian *et al*. (2011) highlight the importance of radical innovation in achieving competitive advantage by employing the latest technology and discarding obsolete methods of production.

Table 3. Top Frequently Referenced Documents.

Ranks	Documents	Citations	Total link strength
1	Latan (2018)	247	30
2	Schaltergger (2012b)	173	17
3	Ferreira (2010)	160	52
4	Qian (2011)	120	32
5	Brown (2014)	232	18
6	Solovida (2017)	90	22
7	Christ (2015)	71	28
8	Gunarathne (2021b)	66	22
9	Burritt (2019)	65	32
10	Qian (2018b)	65	22

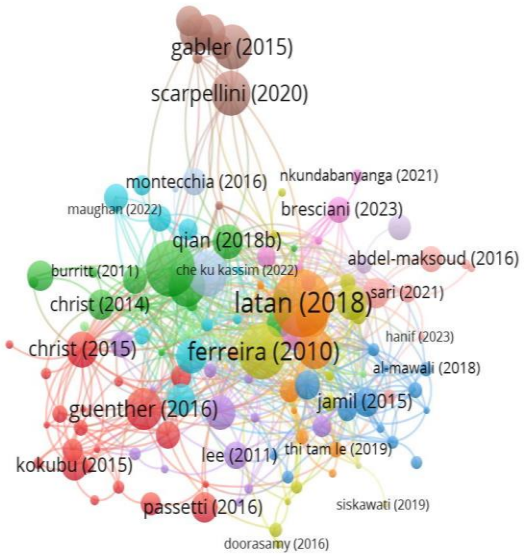

Figure 5. Citation Analysis.

Figure **5** depicts the top cited documents in the area of study EMA, radical innovation, and competitive advantage. Through this analysis, researchers can locate the most impactful intellectual documents that provide valuable insight into the topic. By identifying top-cited documents, researchers can understand the main themes and identify future research directions.

Co-authorship by Country Analysis

The co-authorship analysis technique helps to analyze the patterns of collaboration that exist among various researchers (Yu *et al*., 2020). Table **4** represents the contribution of the top 10 countries in the co-authored publications on EMA, radical innovation, and competitive advantage. The top country that contributed significantly from 2010 to 2024 is the People of China with 43 documents.

Table 4. Top 10 Countries with the Highest Co-authorship .

Ranks	Country	Documents	Total link strength
1	Peoples of China	43	21
2	Australia	37	26
3	USA	31	23
4	England	29	33
5	Germany	28	20
6	Malaysia	28	15
7	Spain	19	5
8	Italy	18	12
9	Netherlands	15	10
10	Thailand	10	6

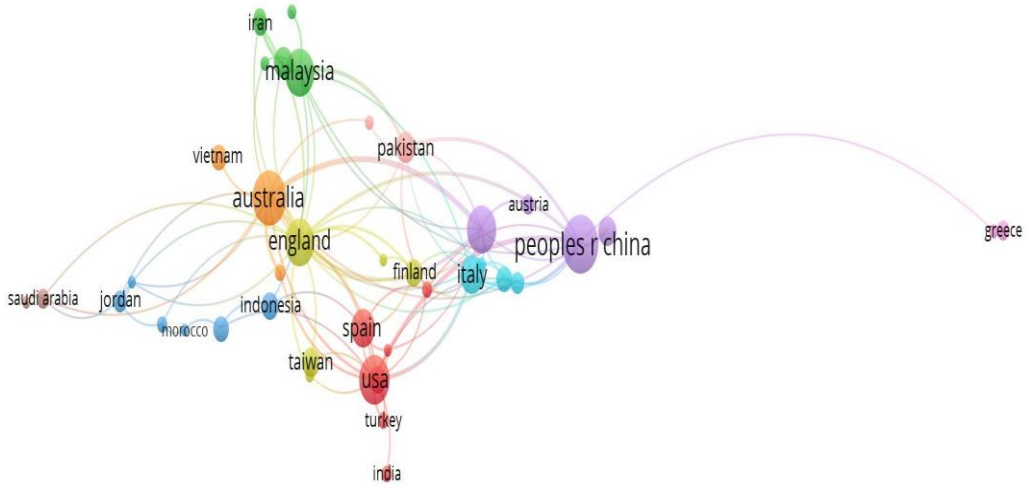

Figure 6. Co-authorship Analysis by Country.

Figure **6** depicts the visual representation of impactful collaboration patterns among different researchers from different countries. This map helps to understand the networks and key countries that are contributing significantly in the area of EMA, radical innovation, and competitive advantage. New researchers can collaborate with these researchers and communities in the future to provide more valuable research studies. Researchers can collaborate with these countries to fill existing literature gaps.

Bibliographic Coupling Analysis

Bibliographic coupling analysis facilitates researchers in visualizing the associations among the shared referenced documents (Tamala *et al*., 2022). Table **5** is based on the results of bibliographic coupling analysis, which was conducted on the WoS database, and it shows the top 10 referenced authors in the area of research EMA, radical innovation, and competitive advantage. The top cited co-authors are Schaltegger and Stefan with 432 citations and 4632 strength links. It depicts that Schaltegger and Stefan have contributed significantly to the literature on EMA, radical innovation, and competitive advantage. The results also demonstrate the interdisciplinary connections in these realms. Aranda-uson and Alfonso are also top-influenced authors with 353 citations and 5156 strength links. These all authors have contributed valuably to the literature and researchers can consider their work to develop a good understanding of EMA, radical innovation, and competitive advantage.

Table 5. Top 10 Referenced Authors.

Ranks	Authors	Citations	Total link strength
1	Schaltegger, Stefan	432	4632
2	Aranda-uson, Alfonso	353	5156
3	Scarpellini, Sabina	353	5156
4	Latan, Hengky	344	1790
5	Portillo-tarrangona, Pilar	342	4133
6	Schaltegger, Stefan	361	3095
7	Lee, Ki-hoon	279	3433
8	Qian, wei	226	2408
9	Marin-vinuesa, luz maria	190	2208
10	Christ, Katherine	184	2076

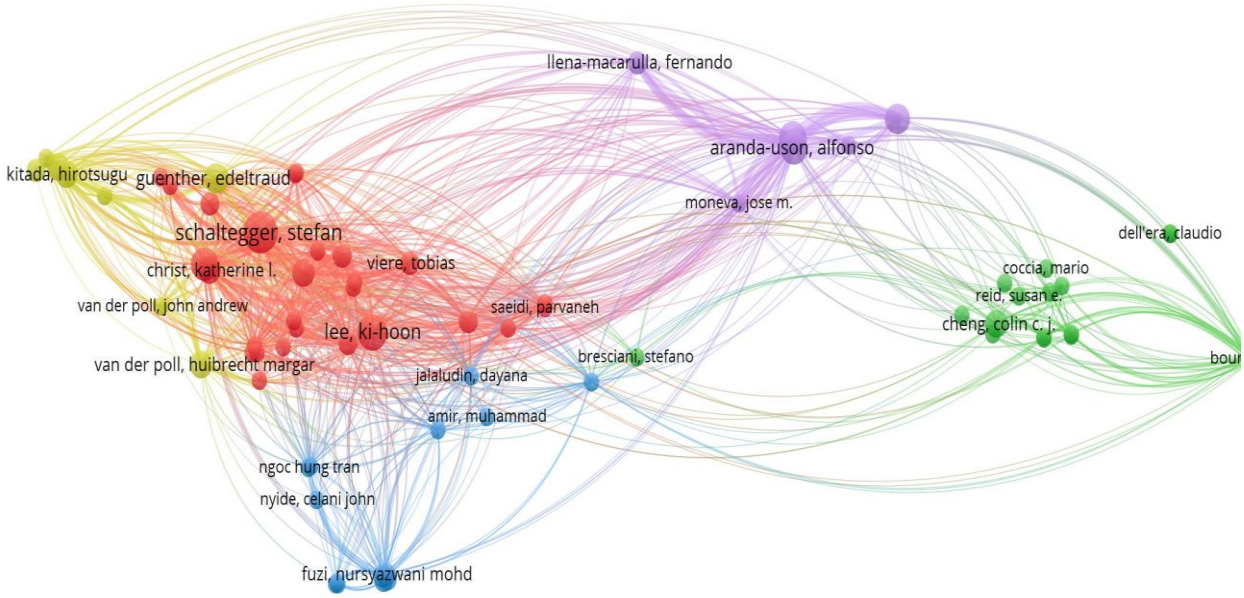

Figure 7. Bibliographic Coupling Analysis

Figure **7** visualizes the top co-cited authors density and these authors are Schaltegger, Stefan, Aranda-son, Alfonso, Scarpellini, Sabina, and others. The network visualization shows the authors who contributed significantly in the area of research of EMA, radical innovation, and competitive advantage. This map represents the most cited research scholars and the collaboration among these authors. This cluster was created by assembling those authors who met the criteria of a minimum of two publications.

Research Implications

Environmental Management Accounting (EMA) and radical innovation are significant research areas that can help organizations achieve a strong market position. These closely related research themes were widely explored by authors. This bibliometric analysis identifies top-cited authors and their works, enabling researchers to examine these sources in-depth and produce valuable future research. Researchers can identify and address research gaps in their future studies. This bibliographic analysis allows researchers to map research networks and explore future collaboration opportunities. This paper helps researchers identify historical data in EMA, radical innovation, and competitive advantage, providing valuable content for their research. This bibliographic analysis will help market practitioners identify industry and technological trends. It will assist them in educating and training their employees about emerging trends and technological development. Practitioners can use this information to develop new, more environmentally friendly and sustainable products.

5. CONCLUSION

This paper identifies the most influential authors, key research documents, top-cited co-authors by country, and main research themes in EMA, radical innovation, and competitive advantage through bibliographic analysis. The study highlights key themes and areas that link EMA with radical innovation to achieve a competitive advantage. It provides a comprehensive overview of EMA research and its role in gaining competitive advantage. The study also identifies top-cited documents that will serve as valuable references for future research and reflects the growing interest in EMA and radical innovation.

The bibliographic analysis offers historical data and identifies key research areas in EMA and radical innovation, providing researchers and industry practitioners with deep insights into these areas. The study emphasizes the importance of adopting EMA over traditional accounting and its benefits for both environmental and financial performance. It indicates a need for more detailed investigation of these key areas.

The study underscores the role of radical innovation in creating environmentally friendly products and promoting green processes. It provides guidance on integrating radical innovation into business strategies to reduce waste and promote sustainability. Additionally, the study identifies research gaps for future exploration. The findings have practical implications for policymakers and managers, highlighting the growing emphasis on adopting the latest technology and EMA. By understanding these key areas, organizations can integrate radical innovation with EMA to address stakeholder concerns and gain a competitive advantage through an enhanced market reputation.

Research Limitations

This study has a few research limitations such as data being collected only from one database, which is the WoS database. In the future, other databases such as Scopus and Google Scholar can be used for more detailed bibliographic analysis. Researchers can use other keywords such as green innovation instead of radical innovation and other keywords to produce more valuable content for literature.

Future Research Direction

This research study highlights the gaps available in the current body of knowledge such as the role of EMA in achieving competitive advantage through radical innovation that has not been studied before. Research scholars can investigate the role of Environmental Management Accounting in implementing radical innovation in organizations. A research study can be conducted to explore how this radical innovation facilitates organizations to increase their financial performance and market reputation. Further researchers can investigate the impact of other variables such as transformational leadership, strategic alliance, and employee engagement.

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