

# Knowledge Mapping of Environmental Cost Management Accounting Research: A Systematic Meta Review

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## Abstract

This paper provides further insights into environmental cost management accounting (ECMA) and identifies factors influencing ECMA practice in enterprises. The study uses bibliometric methods (using VOSviewer software) combined with desk research and synthesis of previous studies. Through the study of 881 ECMA-related publications from 1976 to June 2024, the Scopus database, we have identified some research trends and countries interested in ECMA. We analyze co-occurrences using keywords such as environmental accounting, environmental management accounting, sustainability development, environmental management, etc. The analysis also showed that ECMA can be applied in a variety of fields and industries (manufacturing, mining, tourism, agriculture, etc.) and in different types of enterprises (micro-enterprises, listed enterprises, etc.). More and more countries have been interested in environmental performance. This is confirmed by the fact that ECMA studies were mainly carried out in developed countries before 2012 (USA, Germany, Australia, Japan, China, etc.), but now those also have been conducted in developing countries (Vietnam, Bangladesh, India, etc.). It can be seen that the studies have pointed out the benefits and importance of ECMA in the way towards sustainable development. Thus, more and more organizations and countries are interested in and desire to practice/apply ECMA in their accounting systems. Several theories are related to Environmental management accounting, ECMA, such as contingency theory and institutional theory. Through VOSviewer keyword analysis and data analysis, we have also found seven factors that affect environmental cost information systems in businesses, and then they impact the level of ECMA application. These are coercive pressure, normative pressure, simulation pressure, stakeholder pressure, managers' support and assistance, business strategy, and internal communication. The paper proposes a research model to examine this relationship of factors and the level of ECMA application through the environmental cost information system. The study has some limitations in terms of database size and the quality of publications to review.

**Keywords:** Environmental accounting, Environmental cost management accounting, environmental cost information system, Bibliometric analysis

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## 1. INTRODUCTION

In developed countries, ECMA in businesses receives the attention of both researchers and accounting practitioners. ECMA was officially mentioned in Environmental Management Accounting Procedures and Principles of the United Nations Committee on Sustainable Development (UNSD) in 2001 and the International Federation of Accountants (IFAC) guidance document in 2005. Before the term “environmental cost” was first mentioned in the 70s, until the 90s of the 20th century, the application and research of environmental accounting (EA) was implemented in several countries around the world. Since then, the number of studies relating to environmental accounting (EA) and environmental cost management accounting (ECMA) has increased frequently (every year, there were 40 projects and articles which have been published, especially in the period from 1997 to the present known as a boom in environmental accounting research (Schaltegger, 2011)

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Through research published in Vietnam and around the world, the concept of environmental accounting has continuously developed and focused on the content of environmental management accounting (ECMA). ECMA is a part of environmental accounting. ECMA is not just environmental cost accounting but also accounts for all costs and benefits arising from changes in operational processes that ultimately change the impact on the environment (Boyd, 1998). IFAC (2005) stated that the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. ECMA involves lifecycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management. ECMA incorporates environmental cost factors into regular reports, which are then turned into a basis for business processes and emphasize the efficiency and effectiveness of using resources. Several reasons require companies to implement ECMA ((IFAC), 2005). The United Nations Sustainable Development Agency - UNSD (2001) reached an agreement on the following definition of ECMA: "ECMA is the identification, collection, analysis, and use of environmental information for internal decision making." Bennett and James (1998) offered a different explanation, describing ECMA as "the generation, analysis, and use of financial and non-financial information to optimize corporate environmental and economic performance and to achieve sustainable business." San et al. (2018) defined ECMA as a combined system that provides non-financial and financial information for the smooth operation of the production process, reducing environmental impact and improving the efficiency of the production process. These diverse definitions indicate that ECMA provides necessary environmental, financial, and non-financial data to make informed decisions.

Other scholars such as (Burritt, 2002a; Ferreira 2010; Latan, 2007) agreed with the above-mentioned point of view. They also supposed that ECMA provides both non-financial and financial information, directly impacting an Organization' Environmental Performance. Physical environmental information includes energy flows, waste generation, the number of materials used, water consumption, and emissions, often quantified by environmental or engineering departments (Burritt, 2004). At the same time, financial information is related to environmental costs (Burritt, 2002b). Environmental costs include environmental protection, destruction, and internal and external costs (Ayes, 2010). Accordingly, ECMA has two main functions: (i). Internal function: ECMA is a tool to support decision-making. Through ECMA, managers can manage and analyze environmental protection costs to achieve expected benefits and carry out environmental protection activities effectively. (ii) External Functions: ECMA influences stakeholders' decision-making.

In addition, the content of ECMA was mentioned in various guidance documents published by other accounting organizations and associations, such as the Japanese Ministry of the Environment (JMOE) in 2005, the Institute of Management Accounting Administration (IMA) in 1996, the United States Environmental Protection Agency (USEPA) in 1995, the United Nations Industrial Development Organization (UNIDO) in 2004... In Vietnam, ECMA is mentioned in different documents, which was drafted by authors including Nguyen Chi Quang (2002) (Nguyen, 2003); Pham Duc Hieu and Tran Thi Hong Mai (2012) (Pham. Đ.H, 2012). Their drafts have been considered guiding documents, essential in providing direction and perspective on approaching research on ECMA in businesses. However, ECMA is still considered a new and unpopular accounting method, especially in developing countries, including Vietnam. The application of ECMA in organizations and enterprises has still faced obstacles and barriers (Drury, 1995). The paper uses bibliometric techniques to review the entire development process of ECMA research from 1976 to the present, combined with descriptive statistics to find factors affecting the application of ECMA in enterprises. Thus, the paper will address the following issues:

- i. The distribution of publications over time in the field of EMCA and research trends.
- ii. The most famous authors, the most frequently used keywords, and the leading countries in the field of ECMA research.
- iii. Factors that affect the application of ECMA in organizations.

The main objective of this paper is to present the development of ECMA and its combination using the bibliometric analysis tool. The structure of this paper is as follows: Section 2 describes an overview of the bibliometric analysis method; Section 3 presents the research methodology; Section 4 shows the findings; Section 5 discusses and gives conclusions and future research.

## **2. LITERATURE REVIEW**

The challenges of climate change and the pressure from stakeholders have continuously affected organizations and required them to make major changes in their business operations (West & Boeni, 2023). Governments, customers, investors, and other stakeholders are putting pressure on organizations to adopt environmental protection measures in their business operations (Hanaysha et al., 2022; ...). Organizations are constantly improving the way they operate and directing investments toward sustainable business activities. In response to

this trend, the concept of ECMA was established and considered a useful tool in the field of sustainable business (Ogbonna et al., 2020). Specifically, ECMA began to take shape in the 1970s, when environmental issues became a global priority. By the 1990s, awareness of environmental costs was increasingly focused (Schaltegger & Burritt, 2000). By 2000, ECMA had become more integrated into corporate strategy and sustainability reporting (Baker & Schaltegger, 2015).

The role of ECMA in achieving sustainability goals is noteworthy, and a number of studies have concluded that organizations have improved their efficiency and business performance by adopting ECMA (Ali et al., 2023; Latan et al., 2018). ECMA involves collecting, analyzing, and reporting environmental costs, which helps organizations better understand how business decisions affect their environmental performance (Savage et al., 2017). Research has shown that the adoption of environmental cost management accounting can lead to significant improvements in resource efficiency and waste reduction (Jasch, 2006).

Researchers supposed that ECMA has the function of communicating to stakeholders about the organization's efforts in business activities toward sustainable development. Gray's (2010) findings considered ECMA to be a means to promote transparency, accountability, and the reputation of the organization through auditing and reporting. Through transparency and communication, the organization's efforts will be communicated to stakeholders, thereby enhancing the organization's reputation in the market. On the other hand, practitioners believe that ECMA plays a more direct role in solving problems and supporting the management decision-making process to improve sustainability performance in the organization (Ferreira et al., 2010; Schaltegger et al., 2013). Organizations can strengthen their position in the market by improving environmental sustainability performance. Indeed, studies have shown that organizations that adopt ECMA often create a sustainable competitive advantage, especially in environmentally sensitive sectors such as manufacturing, energy, and retail. A long-term commitment to sustainable practices through ECMA not only increases environmental performance but also helps organizations stand out in the eyes of customers and investors (Renaldo et al., 2022). Furthermore, customers tend to favor organizations that adopt environmentally friendly business practices and contribute to reducing environmental pollution and climate change.

In addition, ECMA provides the information needed to connect the latest technology with business operations, thereby helping organizations improve their environmental sustainability performance. Research by Baker & Schaltegger (2023) has highlighted the role of ECMA in providing important information for management decision-making. While the control and accountability aspects of sustainability accounting are often based on traditional accounting data, strategic decision-making requires a set of environmental information to support a more pragmatic approach (Baker & Schaltegger, 2015). Improved strategic decision-making capabilities enable organizations to act promptly to cope with unpredictable fluctuations and gain an advantage in the market. Previous studies have extensively investigated aspects such as the evolution of ECMA, the adoption of ECMA tools, and their role in monitoring and enhancing competitiveness (Gunarathne & Lee, 2015; Saputra et al., 2023). Globally, more and more organizations are recognizing the importance of ECMA in transforming their business into a sustainable one. However, ECMA implementation still faces a number of challenges, including a lack of public information, a lack of standards, and a lack of internal awareness. These challenges need to be addressed to maximize the potential of ECMA and promote action towards sustainable development.

### **3. BIBLIOMETRIC ANALYSIS**

The term 'bibliometrics' was introduced for the first time by Pritchard (1969) when mathematical and statistical methods were applied to different types of documents (Pritchard, 1969). Bibliometric analysis is a quantitative method to retrospect and describe published articles. This method is useful for researchers synthesizing and evaluating scholarly research in a focused area (Small, 1973); (Rey-Martí, 2016). Bibliometric analysis is a research method that uses data and statistics from academic literature and publication information to evaluate and measure the impact and development of research, authors, journals, or a specific research field. Bibliometric analysis is also used to analyze the network of related bibliographic elements of documents, including co-authoring, co-citation, co-occurrence of keywords, and bibliographic coupling.

To carry out this research, bibliometric analyses were performed in VOSviewer software (version 1.6.20), including 1) Citation analysis and 2) keyword co-occurrence. Citation analysis has long been used to identify prominent authors and documents in fields of knowledge (Zupic, 2015). Co-citation occurs when the third document cites two documents together. Author co-citation analysis provides insight into how authors connect ideas across published works (Chen, 2001). When two authors are frequently cited by different authors (i.e., co-cited), they tend to share intellectual similarities (Small, 1973).

In a keyword co-occurrence network, each keyword is represented as a node, and each co-occurrence of a pair of words is represented as a link. The frequency at which a pair of words co-appears in articles influences the link connecting the pair of words (Radhakrishnan, 2017). Keyword co-occurrence analysis shows the most common keywords appearing in the analyzed documents to conclude that certain documents are on the same topic and are related if they share some of the keywords being identified in the keywords section (Lozano, 2019). Through analyzing the co-occurrence of keywords in ECMA research over time, the authors can identify topics of interest and related topics as well as explore the topic structure, identify topics of most research interest, and also reveal topics of research trends. Radhakrishnan et al. (2017) also asserted that this analysis technique can be performed quickly on large amounts of documents to produce a knowledge map and insights before performing an authoritative review with the strictly traditional system.

#### 4. RESEARCH METHODOLOGY

The materials used for this study are from 'Scopus,' which is a widely recognized scientific source appropriate for research purposes and especially for bibliometric studies (Carlos Suárez-Gargallo & Patrocinio Zaragoza-Sáez, 2023). Scopus was built in November 2004 and owned by Elsevier Publishing (Netherlands) for paid online subscriptions. It is a bibliographic database containing abstracts and citations of scientific articles. Scopus contains 57 million abstracts and nearly 22,000 categories from more than 5,000 publishers, of which more than 30,000 are peer-reviewed journals in Science, Engineering, Health, Society, Arts, and Humanities. In addition, Scopus is a suitable database because it contains a collection of data with complete content and information about the title, author, institution, country, abstract, keywords, references, number of citations, impact factor, and other necessary factors. The sample search period took place on July 3, 2024. The study analyzed publications from 1976 to June 2024. This was the period when ECMA research received a lot of attention in terms of both content and the number of publications. The summary of data source and selection is displayed in Table 1.

Table 1. Summary of data source and selection

| Data source                                | Scopus   |
|--|--|
| Search title, abstract and author keywords | "Environmental management accounting"OR"Environmental cost management accounting"OR"Environmental accounting"          |
| Searching period                           | 1976 to June 2024  |
| Language                                   | English  |
| Document types                             | "Articles" or "Proceeding paper"   |
| Subject area                               | "Business"; "Management"; "Accounting"; "Sustainability" and "Environmental cost management accounting" related fields |
| Data extraction                            | Export with full records and cited references in plain text format   |
| Sample size                                | 881 (After manual screening)   |

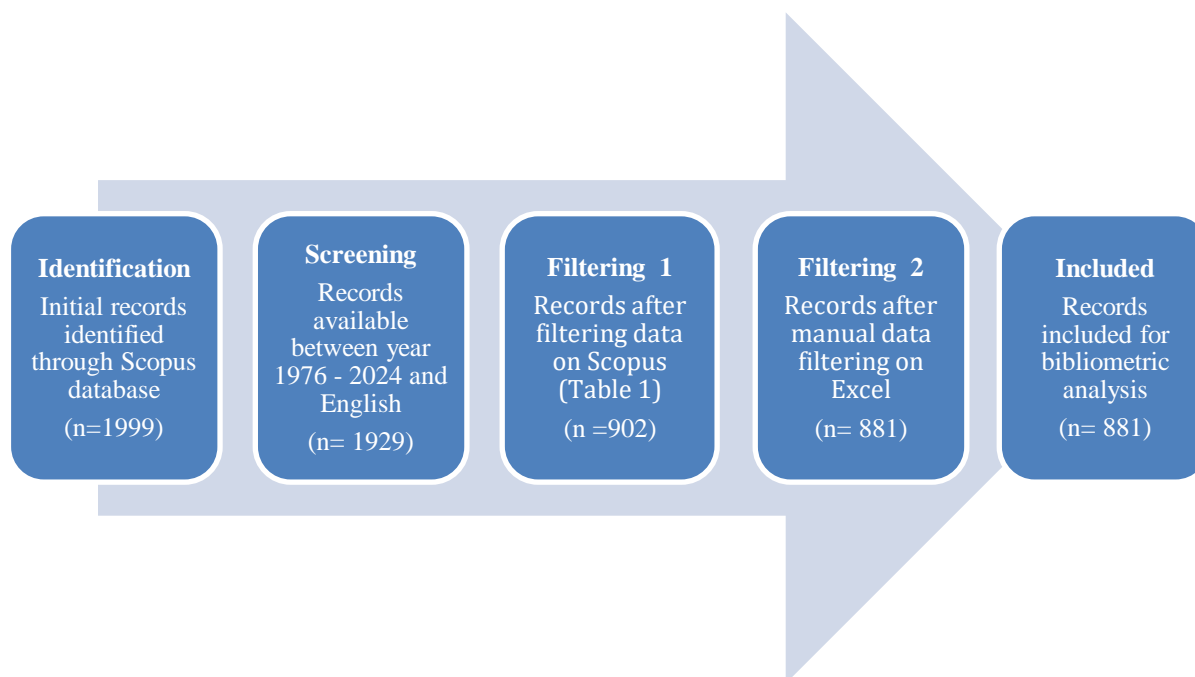


Figure 1. The Process of Data Selection.

After downloading the form from Scopus, several anomalies were noticed: the data displayed were full of errors and/or mistakes in the proper and unique identification of authors, articles, keywords, and citations, entirely contaminating the sample, and so blocking any possibility of carrying out a minimum-accurate analysis. Corrections in all these anomalies were required and took place in order to unify the data and be ready to carry out the analysis on an accurate sample (García-Lillo, 2016a). Specifically, the author manually filtered data in Excel to eliminate publications that did not have complete information (only conference name, no abstract, no citation, etc.). After the sample has been “cleaned,” the authors will use VOSviewer software for analysis. VOSviewer 1.6.20 was used to create different bibliometric networks and map them, thereby identifying the most notable clusters and items.

## 5. RESEARCH RESULTS

This section presents the results of descriptive statistics, maps, and analyses of publications and countries in the field of foundational research. In addition, this section also provides the results of bibliometric analysis performed in VOSviewer software (version 1.6.20).

### 5.1 Descriptive statistics

Through searching and screening, 881 articles and proceeding papers of more than 150 authors in 77 countries were finally obtained (Table 2).

Table 2: Descriptive statistics of the database

| Criteria     | Quantity |
|--------------|----------|
| Publications | 881      |
| Authors      | 150      |
| Countries    | 77       |

#### Documents by year

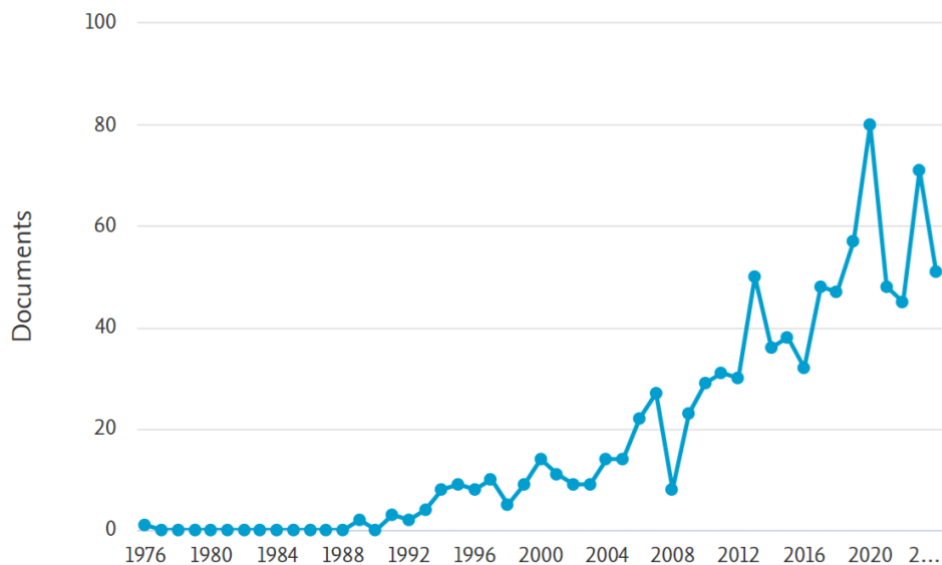


Figure 1: Distribution of publications (Source: Scopus)

Figure 1 shows the distribution of publications in the field of ECMA over time. Research growth trends can be divided into three stages. In the first period from 1976 to 1998, the number of publications published was not much but increased slightly each year, in which 1997 was the year with the most published research (10 publications). This period can be considered as the embryonic stage. The next stage, from 1999-2012, can be considered the seeding stage. The number of published articles had increased significantly during this stage. During this period, 2011 was the year with the highest number of publications, with 31 publications. In the next period, from 2013 to the present, environmental issues have been paid increasing attention. Thus, organizations and countries have also paid more attention to research and application of ECMA. As a result, the number of publications published in this period has increased significantly. The period from 2013 to the present can be considered a period of flourishing research related to ECMA.

## 5.2 General analysis of the publications

Environmental issues have become a hot topic and paid more social attention. Economic development associated with social and environmental development is a top priority of countries and territories. Sustainable development is no longer a national issue but has also become the goal of enterprises. Therefore, ECMA research has also paid more attention to this issue. Since 1976, the number of studies on ECMA has increased in terms of quality and quantity, of which 62% are studies on the general theory and evaluation of ECMA and 38% are empirical studies on ECMA in businesses, manufacturing industries, or countries/territories.

Chart 1: Theory, overview, review and empirical research on ECMA

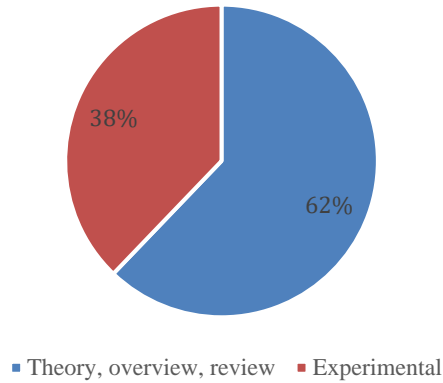
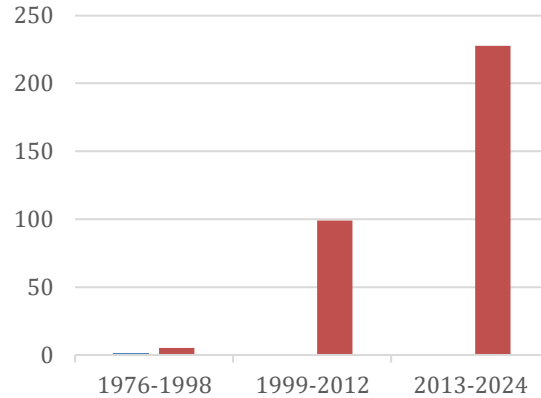


Chart 2: Empirical research on ECMA practice through



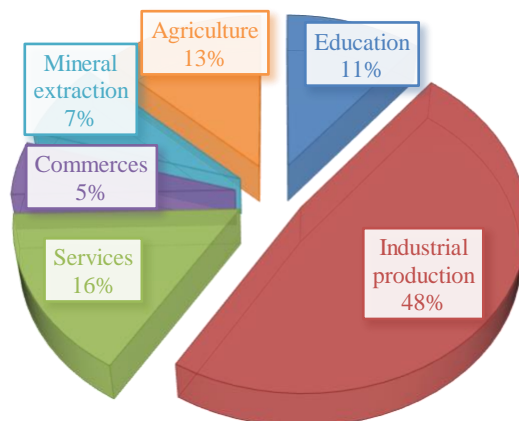
Source: Author's synthesis

Chart 2 shows that the number of studies on ECMA application has increased over time, especially from 2013 to the present. It can be seen that the application of ECMA in enterprises has received more and more attention from researchers, organizations, and countries. The awareness of the benefits and importance of ECMA in improving environmental performance towards sustainable development has been significantly raised.

## 5.3 Analysis Subject area and Country/territory

Research on ECMA is not limited to a specific industry or production field; scientists and organizations in different industries and production fields also apply it.

Chart 3: ECMA research in various fields



Source: Author's synthesis

Through Chart 3, it can be seen that the empirical studies on ECMA are mainly conducted in industrial enterprises (automobile, chemical, pulp, food, ceramic tile manufacturing, etc.). This is because the production and business

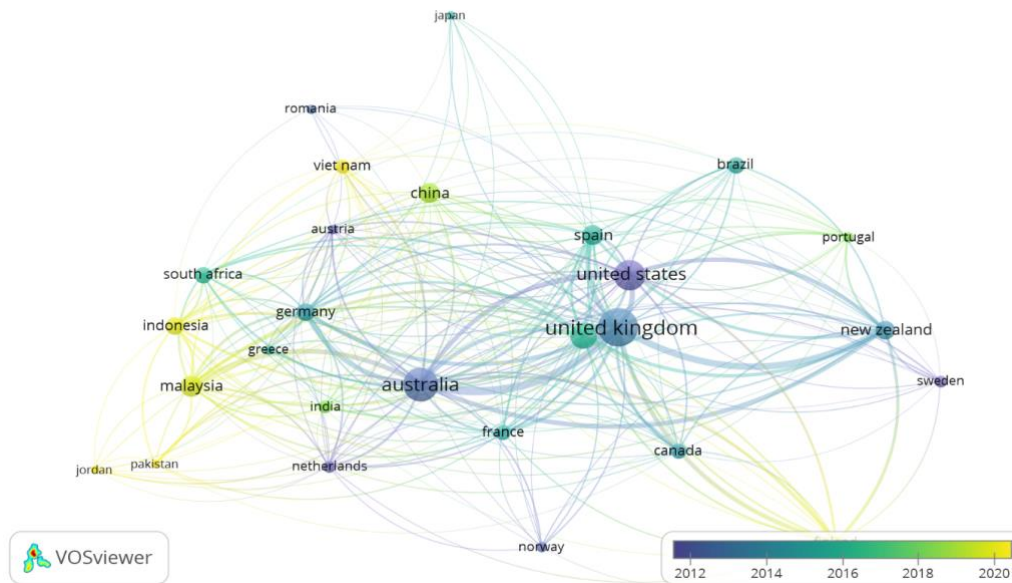
activities of these enterprises often cause negative impacts on the environment, and the costs related to the environment are not small. The second most-researched sector is service. The considered service fields include construction, transportation, tourism, hotels, health care, etc.

Various empirical studies on ECMA have been conducted in agricultural production fields (including aquaculture, logging, livestock, fruit trees, etc.). This is because agricultural production activities are often closely linked to the environment and also have an impact on the environment. Practicing ECMA in enterprises in this field will bring numerous benefits in cost management, improving information quality and environmental performance. Given the social interest in ECMA, scientists have also conducted ECMA research in a number of educational institutions (colleges, universities), examining students' perceptions of and opinions on ECMA. In addition, several studies on the practice of ECMA and ECMA tools have also been conducted in the mineral exploitation sector (oil, gas, gold, etc.). ECMA studies have been carried out not only in a variety of industries and fields but also across different countries. The authors analyzed the distribution of publications by countries and territories in order to identify which countries are most prominent in the field of ECMA research. Below are the top 10 countries and regions at the forefront of ECMA research.

**Table 3:** Documents and citations by country or territory

| Rank | Country and territory | Documents | Citations |
|------|-----------------------|-----------|-----------|
| 1    | United Kingdom        | 162       | 9153      |
| 2    | Australia             | 128       | 6022      |
| 3    | United States         | 103       | 8040      |
| 4    | Italy                 | 71        | 2699      |
| 5    | Malaysia              | 46        | 1014      |
| 6    | Spain                 | 46        | 3104      |
| 7    | China                 | 42        | 888       |
| 8    | New Zealand           | 37        | 3546      |
| 9    | Germany               | 35        | 2636      |
| 10   | Indonesia             | 34        | 822       |

From the data in Table 3, it can be seen that most of the countries and territories in the top 10 are developed countries, such as the United Kingdom, Australia, Italy, etc. These countries impose strict regulations on the environment. In the United States, there are clean air and clean water laws (CAA, CWA), pollution prevention laws, etc. In addition, each state of the United States also has its own environmental laws. In Europe, the EU Ministry of Environment also issues regulations and laws on environmental protection, such as Laws on nature restoration and regulations on environmental standards. In addition, the EU also imposes heavy fines for violations and non-compliance with regulations. China is one of the countries with a number of environmental problems. Thus, in 2014, this country amended the Environmental Protection Law to comprehensively change the awareness and behavior of the entire society as well as enterprises in the Chinese economy. Different articles have been amended to strictly handle violations. As there are increasingly stricter environmental regulations, countries pay more attention to investing in conducting research on environmental issues, including management control and minimizing environmental impacts and costs. In addition, the data cited in Table 5 shows that the United Kingdom, the United States, and Australia are the top countries with the highest number of citations to date. This also shows the reputation of research articles in these countries.



**Figure 2:** Citation analysis on country or territory

Through citation analysis on a country or territory using VOSviewer of 77 countries and selecting a minimum number of documents of a country (8 documents) and a minimum number of citations of a country (27 citations), we obtain the result in Figure 2. The United Kingdom, the United States, Australia, Germany, and New Zealand (purple cluster) are the leading countries in ECMA research; the studies of these countries have been published very early (before 2014). And there is a close link between countries. The green and yellow clusters show countries that conducted development and research later, but the amount of research has increased rapidly over time, including China, Malaysia, Indonesia, Vietnam, etc. In the future, ECMA research will be focused not only on developed countries but also on developing countries.

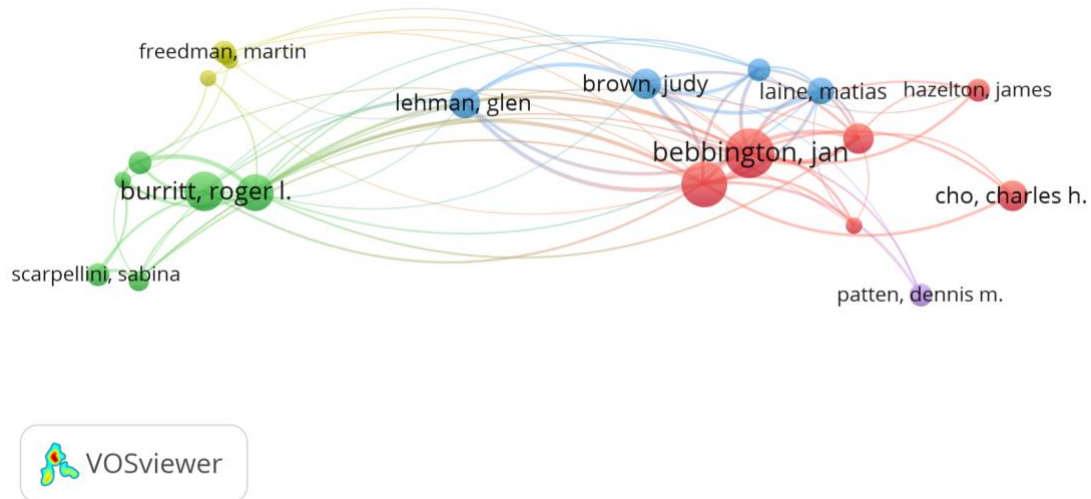
#### 5.4 Co-citation Analysis

Co-citation analysis is a bibliometric technique used to identify the most cited authors in a particular research area. Table 4 shows the top 10 most co-cited and influential authors in the ECMA area. According to the research results, Bebbington, Jan is the most co-cited author with 2362 citations and a total link strength of 133 over the period from 1976 to 2024. Jan Bebbington is one of the pioneers in the ECMA field. Her research has helped raise awareness and practice of businesses integrating environmental factors into management and accounting and promoted the development of sustainability reporting. Ranked 2nd is Gray, with 1799 citations and a total link strength of 123; his research focuses mainly on the development of theory and practice related to environmental reporting, social responsibility accounting, and how organizations can integrate environmental and social factors into traditional accounting systems. Ranked 3rd and 4th are Cho, Charles h., and Petten, Dennis m., with 1679 and 1619 citations, respectively. These are two leading scholars in the field of environmental accounting and corporate social responsibility (CSR), with numerous studies related to the impact of environmental accounting and reporting on the perceptions and behaviors of organizations.

Table 4. Top Cited Co-authors

| Ranks | Authors             | Citations | Total link strength |
|-------|---------------------|-----------|---------------------|
| 1     | Bebbington, Jan     | 2362      | 133                 |
| 2     | Gray, Rob           | 1799      | 123                 |
| 3     | Cho, Charles H.     | 1679      | 13                  |
| 4     | Petten, Dennis M.   | 1619      | 13                  |
| 5     | Brown, Judy         | 1332      | 113                 |
| 6     | Burritt, Roger L.   | 1323      | 25                  |
| 7     | Schaltegger, Stefan | 989       | 70                  |
| 8     | Dillard, Jesse      | 845       | 95                  |
| 9     | Thomson, Ian        | 644       | 52                  |
| 10    | Lehman, Glen        | 556       | 52                  |





**Figure 3:** Citation Analysis

Figure 3 shows the relationship between influential authors through a co-citation network map. Each colored cluster represents a group of authors with a strong co-citation relationship, different colored nodes represent different authors, and the thickness of the connecting line indicates the strength of the co-citation analysis. These nodes represent researchers who have made significant contributions to the ECMA field. Through co-citation analysis, researchers can identify key authors who have made strong intellectual contributions to the field.

### 5.5 Co-occurrence analysis on keywords

We conducted a co-occurrence analysis on keywords using VOSViewer (Figure 4) in order to explore hot topics and potential future topics further. At the same time, the authors also list keywords with frequency over 30 times in Table 5, keywords with higher frequency in the ECMA field.

**Table 5:** High-frequency keywords in

| Keyword                             | Frequency |
|-------------------------------------|-----------|
| Environmental accounting            | 268       |
| Environmental management accounting | 109       |
| Sustainability development          | 106       |
| Environmental management            | 96        |
| Sustainable                         | 77        |
| Accounting                          | 77        |
| Social and Environmental accounting | 68        |
| Environmental economics             | 55        |
| Environmental performance           | 41        |
| Environmental impact                | 33        |

From Figure 4, it can be seen that “environmental accounting,” “environmental management accounting,” “Sustainability development,” and “Environmental management” are the central nodes (also the keywords with the highest frequency in Table 5).

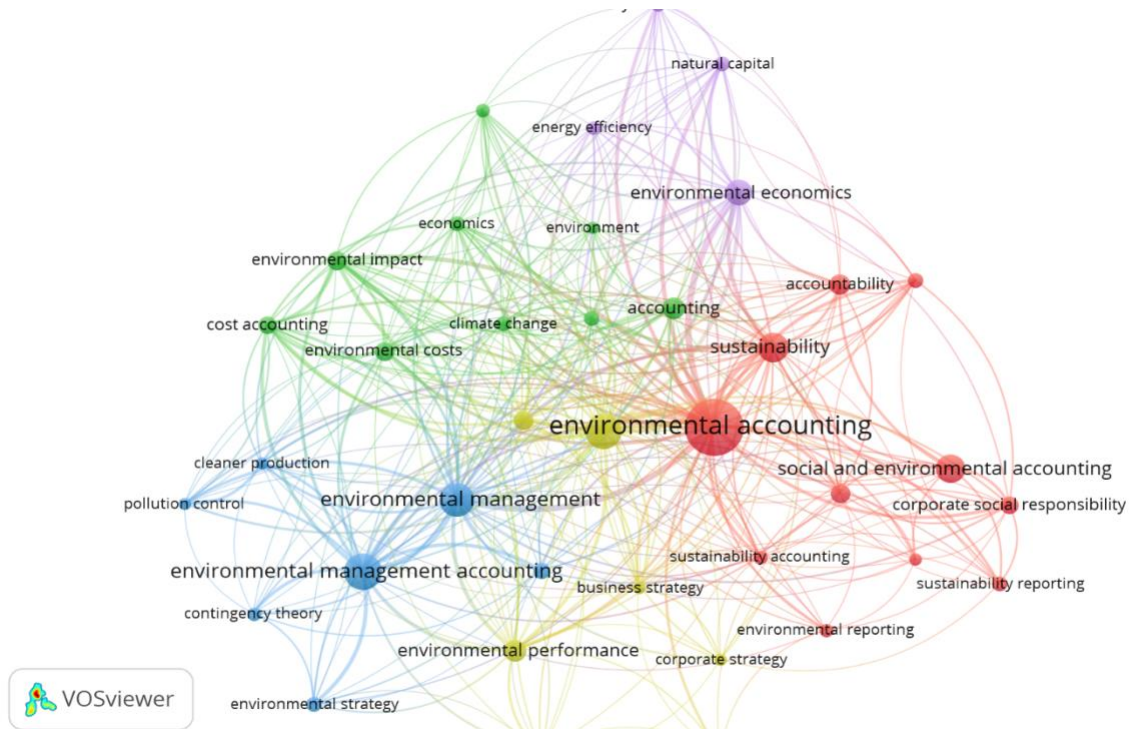


Figure 4: Co-occurrence of keywords (Minimum number of occurrences of A keyword is 13)

By analyzing the co-occurrence of difficult words, we obtained a network consisting of 5 clusters, including Environmental accounting, Sustainability development, Environmental management accounting, Environmental economics, and Environmental impact. The cluster “Sustainability Development” studies the changes in the business strategy of organizations and improves the decisions of managers in accordance with the context of climate change and current environmental regulations. Related issues affecting the practice of ECMA (such as institutional pressures, environmental strategies, clean product trends, etc.) are linked in the cluster “Environmental Management Accounting.” In addition, in this cluster, the items of “contingency theory” and “institutional theory” are closely linked to the Environmental accounting clusters (Figure 5). “Contingency theory” and “institutional theory” are two of the fundamental theories frequently used to find out the factors affecting the application of ECMA in organizations.

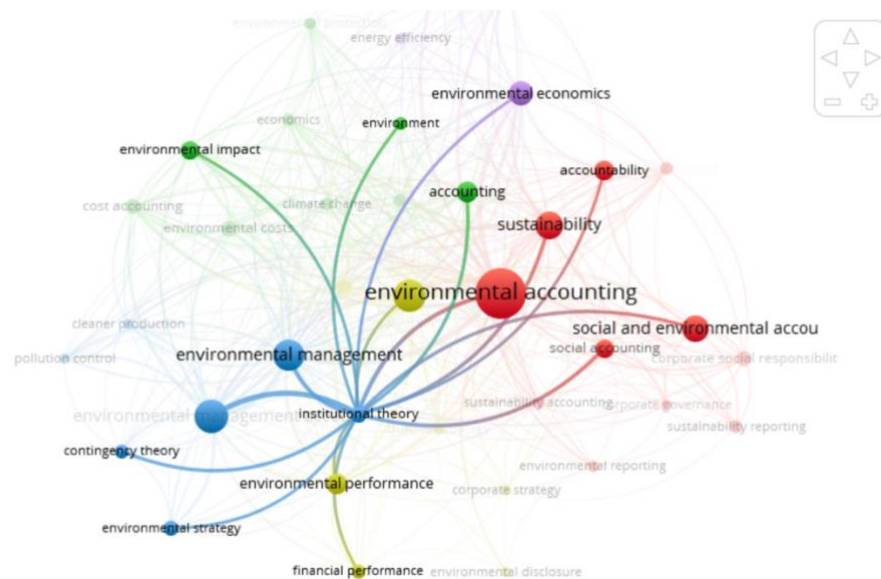


Figure 5: The relationship between “institutional theory,” contingency theory, and other items

The cluster “environmental protection” includes contents related to environmental impacts and environmental costs incurred in organizations. The last cluster, “Environmental impact,” is the smallest cluster, but it is linked to all the remaining clusters, including issues related to the environmental costs of enterprises. These five clusters are closely linked to each other. Due to climate change and increasing environmental pollution, environmental laws and regulations in countries are increasingly tightened. Therefore, Environmental management accounting and sustainability development are clusters that will occupy a dominant position and receive much attention in future research.

## **5.6 Keywords related to factors influencing ECMA practice**

Through searching for items (based on the research theoretical framework) related to factors affecting the practice of ECMA in the database, the authors evaluated these above-mentioned factors as influencing factors on the implementation of ECMA in organizations. The results of the factors are presented as follows:

### **(1) Coercive pressure**

Coercive pressure or government pressure means compliance with existing regulations, which is considered an important variable in the study of institutions and implementation (Abrahamson, 1991; Delmas, 2002; Delmas & Toffel, 2004b; Delmas & Toffel, 2008; DiMaggio & Powell, 1983; Hoffman, 2001; Lapsley & Wright, 2004; Sutton et al. 1994). The previous studies carried out by Chang (2007), Pham Duc Hieu (2010), Jamila (2014), and Le Thi Tam (2017) have shown that coercive pressure has a changing impact on the EC information system by the application of ECMA, thereby affecting the level of ECMA application in enterprises.

### **(2) Normative pressure**

The normative pressure is explained by two factors, including motivation from education, professional development, and members of associations. Practicing ECMA is a difficult task, requiring the participation of experts who have in-depth knowledge. Therefore, when employees are trained and professionally developed, they will be motivated to change and apply useful measures for the organization. In addition, initiatives, reference materials, and guidelines on ECMA provided by professional organizations (IFAC, UNDSO, GRI, ...) create certain institutional pressures for changing EC information systems of the organization in order to provide sufficient information for drafting environmental reports. Therefore, the normative pressure affects the level of ECMA application in enterprises.

### **(3) Simulation pressure**

Scott (1995) supposed that when a behavior or social relationship is accepted and internalized in a field, members tend to behave in a way that is acceptable or noticeable to other members (Qian, W., 2008). This mechanism is called the imitation process, which emphasizes the effects caused by networks of social behaviors and relationships. Similarly, if ECMA concepts and methods are perceived to be widespread in a particular field, organizations operating in this field are more likely to imitate other organizations in applying ECMA concepts and methods to influence the existing EC information system in accordance with the practice of ECMA.

### **(4) Stakeholder pressure**

EC information systems are mainly applied to provide information for internal management. Business managers and external parties will influence the EC information system. Schaltegger & Burritt (2000) pointed out that when an MA information system influences the provision of information to stakeholders, it will affect their interests. Therefore, stakeholders will have a significant impact on changing EC information systems (Chang, 2007). Enterprises will handle EC information systems to practice ECMA because it is a way to legitimize internal operations or to demonstrate that ECMA appears to manage and control environmental activities in response to stakeholder pressure.

### **(5) Business strategy**

According to Ferreira et al. (2010), ECMA represents one of the new developments in management accounting. It is still in the early stages of application and implementation. Thus, ECMA can be considered an innovation in management accounting. According to Oley's study (1999), Simons (1987) pointed out the central role of business strategies in determining the necessary options to achieve the organization's goals. Thus, to practice ECMA, enterprises need to change the EC information system to be in line with their practice of ECMA.

### **(6) The support and assistance of managers**

A number of researchers have emphasized the importance of the support of senior managers in applying information systems and innovations (Bradley & Fund, 2004; Daily & Huang, 2001; Wee & Quazi, 2005; Wong, 2005; Young et al., 2001; Zutshi & Sohal, 2004; Latan et al. 2018). Several researchers such as Kokubu (2002),

Kumpulainen and Pohjola (2006), and Chang and Deegan (2010) have pointed out that the support and assistance of senior managers are considered an essential factor in influencing EC information systems to facilitate or hinder the implementation of ECMA. Baird et al. (2007) measured the support of senior managers by using four items, including authority, communication, sufficient resources, and commitment. Latan et al. (2018) pointed out that when the head of the company (manager) has a commitment to providing accurate environmental information, uses environmental cost information to integrate into the decision-making process, and commits to environmental responsibilities, the level of ECMA application is higher.

**(7) Internal communications**

Internal communication is understood as the level at which divisions and departments of an organization are linked through a network of continuous information communication. To establish an EC information system, cooperation, and information exchange between individuals from different divisions and departments are required, especially between the divisions of production, environmental management, and accounting (Pham Duc Hieu, 2010; Chang, 2007). Therefore, the authors included the internal communication factor in the research model to search for and analyze factors affecting the design of an EC information system in line with the practice of ECMA.

**(8) EC Information System**

The Environmental Cost Information System (ECIS) is a system designed to track, analyze, and report the costs associated with the environmental performance of an organization. This system helps to effectively manage environmental costs and supports the decision-making process. It can be said that EICS is the core of modern environmental management systems and is a prerequisite for stakeholders to have accurate and timely information (Anthony, 2019). According to Spencer (2013), EICS mediates the relationship between the commitment of senior managers and the sustainability and environmental performance of enterprises, as reflected in the level of practicing ECMA. The authors argue that a completed EICS will positively facilitate the practice of ECMA in enterprises.

**(9) The level of ECMA application**

The implementation and application of ECMA have been still in the early stages (Ferreira 2010). Thus, in this study, the authors consider “the level of ECMA application” as a dependent variable. ECMA is an important development of management accounting systems, as well as one of the recent innovations in management accounting, that can help organizations improve both economic and environmental performance toward sustainable development (Schaltegger, 2006). Sustainable development has become one of the goals of a number of organizations, thereby increasing the level of ECMA application (Ferreira 2010).

## **6. CONCLUSIONS AND FUTURE RESEARCH**

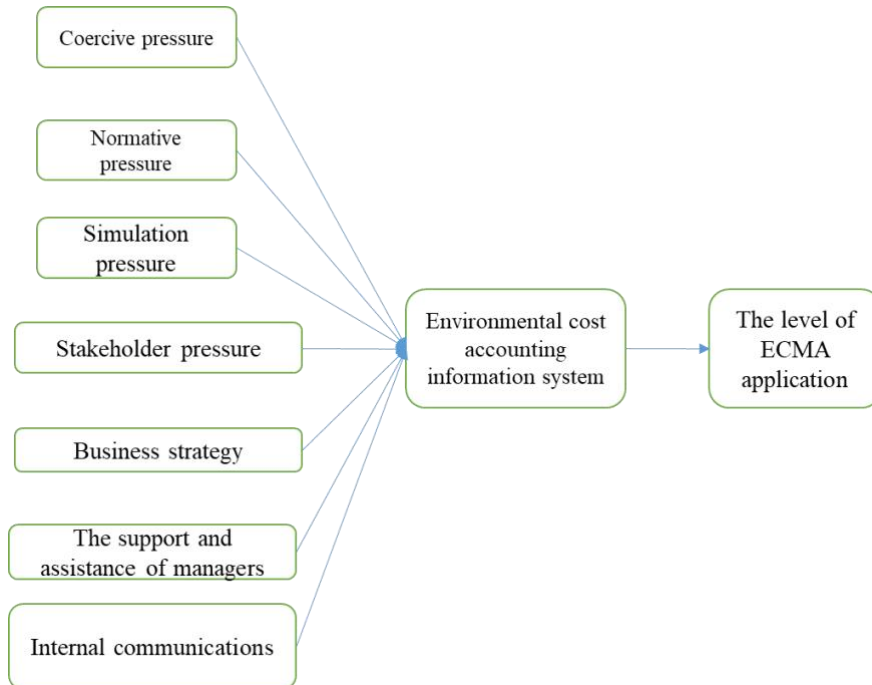
### **6.1 Contributions**

ECMA is a topic that has been shaped by a number of papers over the years, but current research remains chaotic. This study explores the development of ECMA research from 1970 to 2024 using the bibliometric analysis method. Through the analysis of 881 publications obtained from Scopus, the authors find that the number of studies on ECMA overview/theory is higher than that of empirical studies. However, in recent years, the number of empirical studies has increased significantly. In addition, the analysis also showed that ECMA can be applied in a variety of fields, industries (manufacturing, mining, tourism, agriculture, etc.) and in different types of enterprises (micro-enterprises, listed enterprises, etc.). More and more countries have been interested in environmental performance. This is confirmed by the fact that ECMA studies were mainly carried out in developed countries before 2012 (USA, Germany, Australia, Japan, China, etc.), but now those also have been conducted in developing countries (Vietnam, Bangladesh, India, etc.). The study also identified the most cited papers that will serve as valuable references for future research and reflect the growing interest in ECMA. The bibliometric analysis provides researchers and industry professionals with insights into ECMA. The study highlights the importance of adopting ECMA over traditional accounting and its benefits in controlling environmental costs and environmental performance. It also points out the need for further detailed research in this area.

In addition, through keyword analysis, the study also finds out the connections related to ECMA (sustainability development, environmental management, environmental economics, etc.) and theoretical frameworks commonly used in the study (institutional theory, contingency theory, etc.). From there, a research model of factors affecting the level of ECMA application in enterprises is proposed. However, due to time constraints in the research, the authors did not collect opinions from experts. In future studies, the authors will gather opinions from experts and apply this integrated model to a specific manufacturing industry.

## 6.2 Future research

Through bibliometric analysis, this study is useful in describing a comprehensive framework of ECMA research and supporting future researchers. The proposed research model is suggested for examining and finding the factors that affected ECMA in Figure 6.



**Figure 6:** The proposed research model

However, this study also has some limitations. First, the sample in this study was drawn from only one database. Although Scopus includes many different journals, it cannot cover the entire range of journals on the subject of ECMA. Second, to ensure high-quality publications, data collection in this article is limited to two types of publications (articles and Proceeding papers). Future research could expand the data collection through other types of publications (e.g., reviews and working papers), which could provide additional insights and the latest findings in the field of ECMA. Finally, although bibliometric analysis using specialized software is objective, the subsequent interpretation of the results is somewhat subjective. It is possible that different researchers have different perceptions and interpretations of the same content.

The authors hope that this study can also be used as a reference to assist researchers in choosing journals to submit their articles. The results of this bibliometric analysis can also propose the research model with related factors. This section presents the results of descriptive statistics, maps, and analyses of publications and countries in the field of foundational research. In addition, this section also provides the results of bibliometric analysis performed in VOSviewer software (version 1.6.20).

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