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Research Article

Targeted Bibliometric Analysis of CO_2 Reduction in Concrete Using Dune Sand and Supplementary Cementitious Materials

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Abstract:

Abstract should be about 100-250 words. It should be written times new roman and 10 punto. This study provides a systematic bibliometric analysis of research on concrete incorporating dune sand and supplementary cementitious materials (SCMs), with a focus on the reduction of CO2 emissions and sustainable construction. Data were retrieved from the Scopus database, covering publications from 2001 to 2025, resulting in a dataset of 28 records. The dataset was imported into Biblioshiny, the web interface of the R-based bibliometrix package, and analyzed using performance and knowledge structure metrics. The results suggest that while the field is still emerging, it has experienced steady growth over the last two decades, with an annual growth rate of 4.68% and a peak in publications in 2024. International collaboration is high (53.57%), highlighting the global interest in sustainable concrete research. Key journals, such as Construction and Building Materials, serve as primary outlets for dissemination, whereas authors and countries such as El-Hassan H, the United Arab Emirates, China, and Algeria demonstrate leading contributions. Thematic analysis identifies dominant topics including sustainability, CO2 emission reduction, mechanical and durability properties of concrete, and the use of locally sourced materials like dune sand and SCMs. These findings have noteworthy implications for both research and industry. For academia, the analysis highlights influential authors, journals, and collaboration networks, guiding future research directions. For industry, the results provide evidence-based insights into the practical potential of dune sand and SCMs in sustainable concrete formulation, supporting low-carbon construction initiatives. Moreover, the emerging trends and highly cited recent studies indicate avenues for innovative research, includ- ing novel SCMs, durability assessment, and performance optimization under diverse environmental conditions.Overall, this study demonstrates the growing international focus on environmentally sustainable mate- rials in concrete, offering a structured overview of scientific production and guiding both researchers and practitioners toward effective strategies for CO2-reducing concrete development.

1. Introduction

Sustainable construction and the reduction of CO_2 emissions in concrete production have emerged as critical challenges in modern civil engineering, driven by environmental concerns, regulatory pressures, and the urgent need for low-carbon building materials (Scrivener, 2018),(Barbhuiya et al., 2025). Among various strategies, the use of dune sand and locally available supplementary cementitious materials (SCMs) has shown great promise in enhancing the mechanical performance of concrete while reducing its environmental footprint (Zhang et al., 2022), (Akhtar et al., 2024), (Chadli et al., 2023). Despite growing interest, a comprehensive understanding of the scientific landscape in this domain remains limited (Abdelkadir et al., 2023).

This study analyzes research on dune sand and

SCM-based concrete, focusing on publication trends, themes, and key contributors using Scopus data. The research questions (RQs) are:

RQ1 : What are the general characteristics and annual growth of the literature on dune sand and SCM-based concrete?

RQ2 : Which journals and sources are most influential in this research domain?

RQ3 : Who are the most productive authors and countries contributing to this field?

RQ4 : Which documents have the highest impact?

RQ5 : What are the major keywords and emerging themes in this research field?

By analyzing these aspects, this study provides an integrated overview of the field, highlighting emerging trends, influential publications, and potential directions for both research and practical ap- plication. Ultimately, it aims to guide researchers and practitioners toward environmentally conscious and high-performance concrete solutions.

2. Materials and methods

This study uses bibliometric analysis to evaluate research on dune sand and SCMs in concrete, emphasizing CO_2 reduction and material performance. The methodology directly addresses the research questions presented in Section 1.

2.1 Search Strategy and Keywords Selection

The bibliometric search was conducted in the Scopus database using the TITLE-ABS-KEY fields (title, abstract, and author keywords) to capture thematically relevant publications.
The exact query executed was:
TITLE-ABS-KEY ((“CO_2 emission*” OR “carbon dioxide emission*” OR “CO_2 reduction” OR “carbon footprint” OR “greenhouse gas emission*” OR decarbonization OR sustainability) AND (“concrete” OR “cement” OR “Portland cement”) AND (“dune sand” OR “desert sand” OR “local sand”) AND (pozzol* OR “supplementary cementitious material*” OR SCM OR “mineral additive*” OR “natural pozzolan*” OR “industrial by-product*” OR slag OR “fly ash” OR “calcined clay” OR metakaolin OR “rice husk ash” OR “silica fume” OR charcoal OR biochar OR “carbon-based additive*”) AND (“mechanical properties” OR “physical properties” OR durability OR “thermal properties” OR rheology OR “hydration kinetics” OR strength))
The search was performed on 20 July 2025 with no filters, retrieving 28 documents spanning 2001– 2025. The dataset was exported in CSV format and analyzed using Biblioshiny, the R-based interface of the bibliometrix package (Aria and Cuccurullo, 2017).
Note: Data for 2025 are partial, as the year was incomplete at the time of the search.

2.2 Document Collection

The dataset was retrieved from the Scopus database using the search strategy outlined in Subsection 2.1. The bibliographic records were exported in CSV format and processed through Biblioshiny for further analysis. However, the absence of Cited References (CR) and Science Categories (WC) within the exported dataset restricts the performance of co-citation, historiographic, and network analyses.

2.3 Visualization and Analysis Workflow

Figure 1 presents the workflow of the bibliometric analysis conducted in this study.

3. Results and discussion

3.1. RQ1: What are the general characteristics and annual growth of the literature on dune sand and SCM-based concrete?

3.1.1. Main Information

Table 1 summarizes the general characteristics of the dataset retrieved from Scopus.
The dataset is modest but shows steady growth (4.68%). The literature is relatively recent (average age of 4.29 years) and moderately cited (12.71 citations per document). High international collaboration (53.57%) indicates strong global engagement. As noted in Subsection 2.2, the exported records lacked Cited References and Science Categories, which restricts co-citation, historiographic, and certain network analyses. Finally, the predominance of journal articles (20) over conference papers (7) suggests maturity in publication practices while also reflecting dissemination of emerging results.

3.1.2. Annual Scientific Production

Figure 2 illustrates the number of articles published per year.
Research was sparse from 2001 to 2017, with

intermittent years of zero output (2002–2008, 2015–2016). Activity increased steadily after 2018, peaking at nine publications in 2024, indicating growing con- solidation around dune sand and SCMs. These findings suggest an increasing interest in sustainable alternatives for cement-based materials, aligning with broader global trends in eco-friendly construc- tion research ((Juenger et al., 2019), (Yao and Hong, 2024), (Suarez-Riera et al., 2024).

3.2. RQ2: Which sources are most influential in this research domain?

3.2.1. Most Relevant Sources

Figure 3 presents a refined visualization of the five most relevant sources in the dataset.

The results indicate that Construction and Building Materials is the leading outlet, publishing nearly one-fifth of all documents (5 out of 28). This dominance reflects its recognized status as a primary venue for research on cementitious materials and sustainable construction (Yao and Hong, 2024). In contrast, other journals contributed few publications, suggesting that research on dune sand and SCM-based concrete is still scattered across diverse outlets.

3.3. RQ3: Who are the most productive authors and countries?

3.3.1. Most Productive Authors

Figure 4 illustrates the distribution of publications among the top 10 most productive authors.The balanced distribution of publications suggests that this research area is still developing, where collaboration rather than individual dominance drives most contributions.

3.3.2. Most Productive Countries

As shown in Figure 5, the United Arab Emirates, China, and Algeria dominate the research output, followed by Saudi Arabia and Malaysia. The UAE and China lead in absolute production, reflecting their strong investment in sustainable construction materials research. Algeria also shows a notable presence despite a smaller research ecosystem, underscoring its regional commitment to dune sand utilization. Other countries contribute modestly but consistently, suggesting expanding geographical interest in the topic. RQ4: Which documents have the highest impact?

3.3.3. Most Globally Cited Documents

Table 2 lists the five most globally cited documents.

These results indicate that while older papers (e.g., **Zhang M 2022**, **Saberian M 2018**) maintain the highest total citations, several recent studies (e.g., **Akhtar MN 2024**, **Hwalla J 2023**) are rapidly gaining attention. This pattern reflects emerging trends in research on sustainable concrete and CO_2 reduction strategies, highlighting the growing impact of newer publications despite their shorter circulation time.

3.4. RQ5: What are the major keywords and thematic trends in this research field?

3.4.1. Major Keywords

Figure 6 provides two complementary visualizations of keyword prominence and relative importance.

Keyword analysis reveals the dominant concepts in the field. The most frequent terms are **compressive strength** (13), **sand** (10), **desert sand** (9), **fly ash** (9), **Portland cement** (9), and **slags** (9). These terms indicate a strong research focus on the mechanical performance of concrete and the use of alternative or supplementary cementitious materials. In parallel, sustainability-oriented keywords such as **sustainable development** (9), **cements** (7), **concretes** (7), and **sustainability** (7) reflect anincreasing emphasis on environmentally responsible construction practices and the transition toward greener materials.

3.4.2. Thematic Trends

Topic evolution Table 3 shows a shift from traditional materials to sustainability and sand use. Early studies focused on **concretes** and **Portland cement** (2018). From 2019, themes expanded to **slags**, **cements**, **sustainable development**, and **fly ash**. In 2023–2024, research increasingly addressed **sand**-related terms (**sand**, **desert sand**, **dune sand**, **dunes sands**) often linked to **compressive strength**.These results indicate a clear shift from traditional concrete materials toward sustainable and locally sourced alternatives. The increasing frequency of sand-related keywords in 2023–2024 may reflect emerging environmental concerns, resource considerations, or new construction practices.

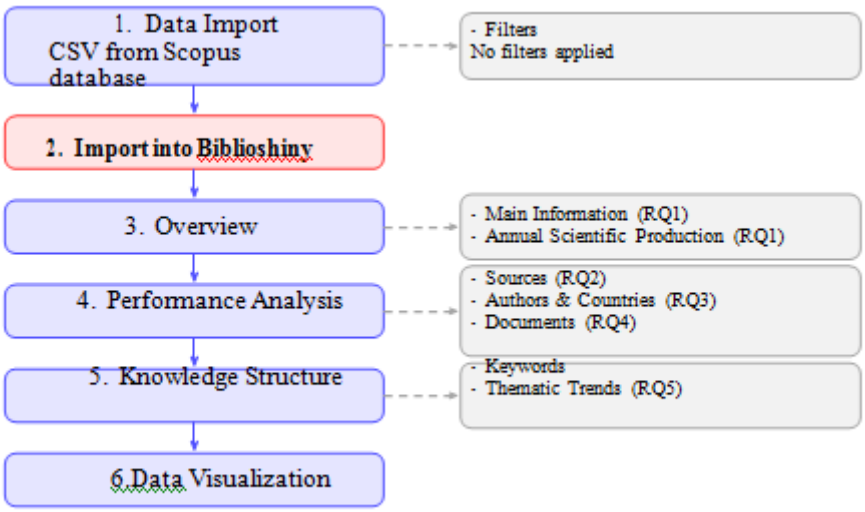

Figure 1. *Workflow of the bibliometric analysis process.*

Table 1. *Main information about the dataset.*

Description	**Results**
Timespan	2001–2025
Sources (Journals, Books, etc.)	22
Documents	28
Annual Growth Rate (%)	4.68
Document Average Age	4.29
Average Citations per Document	12.71
Authors	94
International Co-Authorships (%)	53.57
Document Types	Article (20), Conference Paper (7), Review (1)

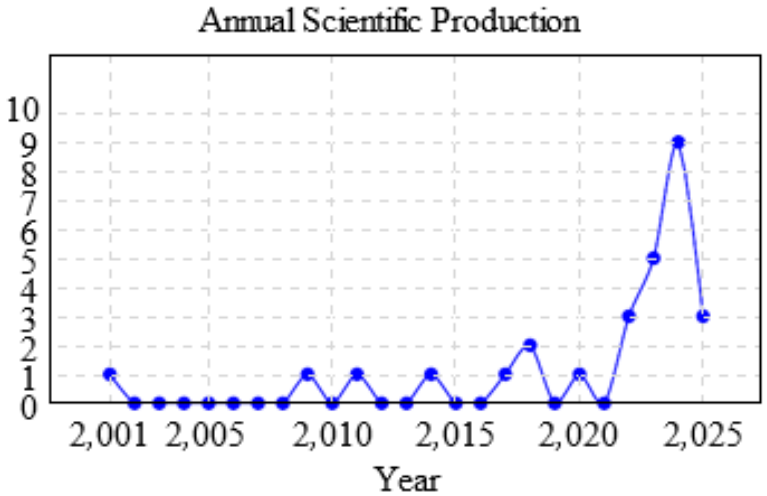

Figure 2. *Annual scientific production from 2001 to 2025.*

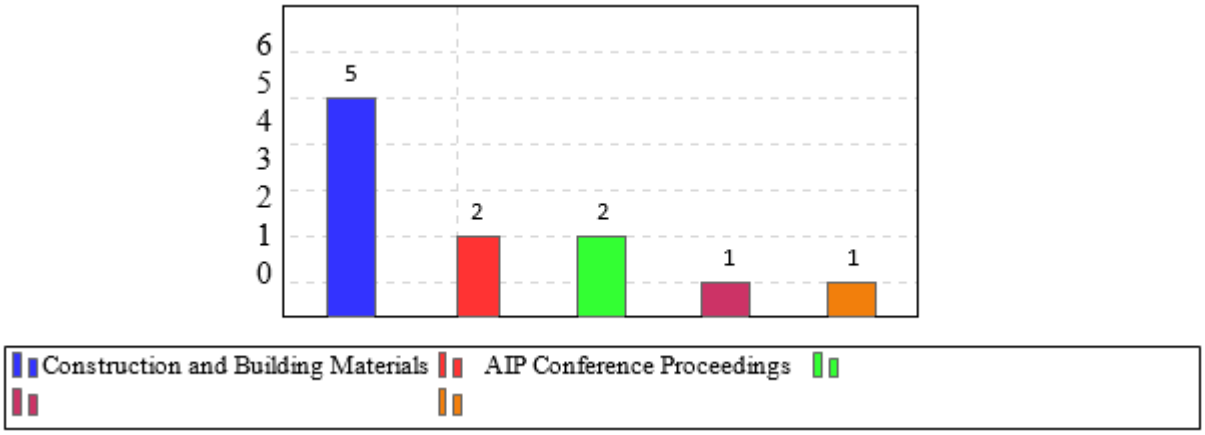

Figure 3. *Top five most influential sources (2001–2025).*

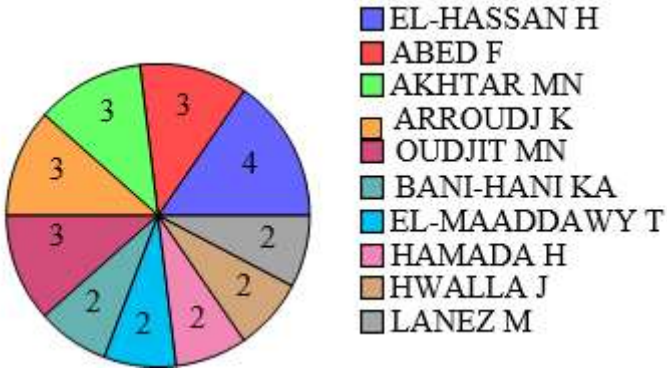

Figure 4. *Donut chart of most productive authors (2001–2025). Size of each slice corresponds to the number of articles.*

Figure 5. *Country scientific production (2001–2025). Countries with higher number of publications are shown in darker blue.*

Table 2. *Top 5 most globally cited documents (2001–2025).*

Paper	DOI	Total Citations
Zhang M, 2022, Constr Build Mater	10.1016/j.conbuildmat.2022.127014	73
Huynh T-P, 2022, Constr Build Mater	10.1016/j.conbuildmat.2022.128512	44
Saberian M, 2018, Geomech Eng	10.12989/gae.2018.14.6.553	42
Hwalla J, 2023, Case Stud Constr	10.1016/j.cscm.2023.e02037	29

(a) Word cloud visualization of dominant terms.

(b) Treemap representation of keyword frequency.

Figure 6. *Most frequent keywords and their distribution (2001–2025).*

Table 3. *Trend topics over time (2001–2025).*

Term	Freq.	Q1	Median	Q3
Concretes	7	2012	2017	2020
Portland cement	9	2011	2018	2024
Slags	9	2017	2022	2023
Sustainable development	9	2017	2022	2023
Cements	7	2019	2022	2022
Compressive strength	13	2020	2023	2024
Sand	10	2022	2023	2024
Fly ash	9	2022	2023	2024
Desert sand	9	2023	2024	2024
Dunes sands	6	2022	2024	2024

4. Conclusions

This study set out to identify and analyze the global research trends on CO2 reduction in concrete through the use of dune sand and supplementary cementitious materials (SCMs). The results suggest that while the field remains emerging, it has experienced steady growth over the last two decades, with a focus on sustainability, mechanical performance, and the use of locally sourced materials.

These findings have noteworthy implications for both research and industry. Specifically:

• Scientific impact: Identifying leading journals, authors, and countries highlights collaboration opportunities and guides publication strategies.

• Practical applications: Findings on dune sand and SCMs support low-carbon concrete in arid regions, promoting sustainable construction and policy adoption.

• Research directions: Trends reveal a shift toward sustainable binders (slags, fly ash, dune sands). Future work should assess new SCMs, durability, and performance optimization.

Overall, the study demonstrates that although research on CO2-reducing concrete with dune sand and SCMs is still developing, there is strong and growing international interest.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
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- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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