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Research Article

Bridging Perspectives between Bibliometric Analysis and Data Analytics in the Realm of Literature Study: A Case Study Exploration

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ABSTRACT

Bibliometrics involves the quantitative analysis of publication patterns, citation statistics and research trends, providing crucial insights into academic impact and emerging study areas. This comparative analysis explores the innovative and ever evolving horizon of bibliometric analysis in academia and research. In the era characterized by a rapid increase in academic publications, the imperative to employ data analytics tools for extracting knowledge and making informed strategic decisions has grown substantially. This paper highlights the growing importance of data analytics tools in bibliometric analysis amidst the surge in academic publications. By transitioning from traditional literature reviews to advanced tools like VOSviewer, Origin Lab, SPSS and machine learning, the study illustrates how these technologies enhance bibliometric studies. A case study on nutrient recovery from human urine, analysing 520 refined papers from Scopus and Web of Science, demonstrates the application of these tools in identifying research trends, geospatial distribution and collaboration networks. This methodology underscores the effectiveness of data analytics in addressing real-world research challenges and advancing the field of bibliometrics.

Keywords: Bibliometrics, Bibliometric Analysis, Data Analytics, Urine, Nutrient Recovery.

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INTRODUCTION

An important science in understanding the dynamics of academic communication, the influence of research and the evolution of knowledge, bibliometrics has arisen in an era characterized by information overload and the digital revolution of academia (Kamboj and Sudhir Kumar Tyagi, 2024). As academic landscapes continually expand, it becomes increasingly challenging to discern trends, measure scholarly output and gauges the influence of individual researchers, institutions, or scientific fields (Subramanyam, 1983; Rodriguez, 2006). Conventional literature reviews are highly valuable for providing in-depth qualitative insights into the existing literature. They require a thorough understanding of the subject matter and critical analysis skills. Conventional literature reviews are a common approach to summarizing and synthesizing existing knowledge in a particular field of study by methods such as manual search and selection, qualitative analysis, narrative synthesis, citations and references (Spiegel-Rosing, 1977; Purcell *et al.*, 2007). Quantitative evaluation measures, such as indicator-supported methods like bibliometrics, have become increasingly important since the 1990s. This is especially true in budgeting choices where figures are easier to compare than opinions from peers and can be produced more quickly. When comparing a big number of units, such as many research groups or institutions, quantitative techniques can be very helpful in providing crucial information for quality assessment because individual specialists are not able to handle this much information in a single review procedure (Bornmann, 2020). For instance, bibliometric data is given greater weight than peer review in the new UK Research Excellence Framework (REF) than in the previous one (Haunschild *et al.*, 2016; King, 1987). However, they can be time-consuming and subjective, as the selection and interpretation of papers depend on the reviewers' judgment. Additionally, these reviews may struggle to keep up with rapidly evolving fields and may not cover the entire body of literature comprehensively and lacks scope, subjectivity and facing difficulties in tracking trends. As research landscapes continue to evolve and generate vast amounts of data, bibliometric studies are becoming an increasingly suitable

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approach to complement conventional literature reviews, offering objective, quantitative and efficient methods for analysing and synthesizing the literature. Bibliometric studies and analysis are especially helpful for researchers who want to see the body of work from a wider angle, evaluate the significance of their work and objectively and methodically monitor trends (Taylor, 2012; White and McCain, 1998). According to the study of Donthu *et al.*, 2021, it is clear that the approach of bibliometrics is not new as there has been discussion of bibliometrics since the 1950s (Wallin, 2005). However, the expansion of bibliometrics in the domains of "business, management and accounting," "economics, econometrics and finance," and "social sciences" on Scopus using "bibliom*" as a keyword in the "article title, abstract and keywords" indicates that bibliometrics is still relatively new. Bibliometric approach has opened a new horizon of literature study be objective analysis, data visualization, comprehensive coverage of real-time data. Dealing with large volumes of scholarly publications and citation data, a data analytical approach to bibliometric analysis comes up using quantitative methods, data mining and visualization techniques to analyse and extract insights from metadata (Bornmann and Leydesdorff, 2014; Mukesh Behera and Meher, 2024; Giske, 2008; Hood and Wilson, 2001).

Conventional Literature Review vs. Bibliometric Analysis

The 20th century saw a significant expansion of scientific knowledge and an explosion of research publications. To balance the quantity and quality of literature review, from the last few decades, the academic world is inculcating meta-analysis, bibliometric analysis and systematic review in the research work along with conventional review methods. Meta-analysis is a quantitative method that indicates the strength of variable associations for the studies that are part of the analysis using certain metrics (e.g., an effect size). The method places more emphasis on findings from several studies than on findings from a single one (Shelby and Vaske, 2008) (Borenstein *et al.*, 2021). Along with that, to stay abreast of the vast and swiftly expanding corpus of knowledge, researchers and healthcare professionals depend on high-quality, current systematic reviews. Using clear, repeatable procedures to locate, evaluate and synthesize primary research study findings, systematic reviews provide answers to predetermined research questions (Wilson, 2012). Clarifying objectives and techniques in a protocol, locating pertinent research, gathering data, evaluating study quality, synthesizing evidence and interpreting results are important steps in the creation of systematic reviews. Numerous problems can be addressed by systematic reviews, including those concerning the efficacy of therapies, the accuracy of diagnostic tests, prognosis, the prevalence or incidence of illness, the precision of measuring tools and qualitative data. Determining possible risks of bias and defining criteria such as the population, intervention, comparison and outcomes are crucial for any reviews (Zoss, 2012). Assessments of the efficacy of medications for the prevention or treatment of stroke may not be as methodologically demanding as assessments of the impact of rehabilitation programs, data from observational studies, diagnostic test accuracy, or qualitative data (Pollock and Berge, 2018). A comparison tree map of different literature review methods are elaborated in Figure 1.

In response to this growth, the conventional literature review became a standard feature of scholarly work. Researchers started writing comprehensive review articles that summarized existing knowledge, identified research gaps and suggested future directions. Conventional review of literature is totally based on qualitative and summary-based approach of existing work on some topic of interest (Li and Wang, 2018) (Paul and Barari, 2022). These reviews typically involve the elements detailed below.

Manual Search and Selection

Conventional literature reviews begin with researchers conducting comprehensive searches across various information sources such as library catalogues, online repositories and academic search engines. They use keywords, Boolean operators (AND, OR, NOT) and other search techniques such as nested Boolean operators, truncation and wildcards, phrase searching to identify a broad set of relevant publications. After generating an initial list, researchers screen the titles and abstracts to exclude irrelevant papers. The final selection is based on a combination of the paper's relevance to the research question and its quality, which includes factors like the study's methodology and the credibility of the source.

Qualitative Analysis

Once the relevant papers are identified, researchers engage in in-depth reading and qualitative analysis of these publications. They examine the content to extract key findings, research methods, arguments and any limitations or biases within the studies. This qualitative analysis is often organized thematically, allowing researchers to categorize and group related information.

Narrative Synthesis

After conducting the qualitative analysis, researchers synthesize the information into a coherent narrative. This synthesis can be organized in various ways, such as chronologically (to show the historical development of the field), thematically (to group findings by themes or topics), or by study design (to compare and contrast research methods). The narrative often highlights the evolution of thought in the field, identifies gaps in the existing literature and provides context for the research question under investigation.

Citations and References

During the manual search process, researchers often identify relevant papers through citations in the reviewed literature. Additionally, they create a bibliography of the reviewed papers to reference in their own work. Researchers may also manually track citations and references to key papers to understand their influence and the impact they have had on subsequent research. (Rozas and Klein, 2010)

On the other hand, bibliometric study, being an upcoming approach, focusses of quantitative analysis of existing work over in-depth abstract analysis (Subramanyam, 1983). Bibliometric studies, using quantitative analysis, offer a complementary approach to conventional literature reviews and they are gaining popularity for several reasons:

Objective Analysis

Bibliometrics provide an objective and systematic way to analyse large sets of academic publications. Metrics such as citation counts, co-authorship networks and h-index can help assess the impact of research.

Comprehensive Coverage

Bibliometric analysis can cover a vast number of papers and provide insights into the entire body of literature on a topic, helping researchers identify seminal works and emerging trends.

Visualization and Mapping

Bibliometric tools and techniques enable researchers to create visual representations of the research landscape, making it easier to spot patterns, clusters and gaps in the literature.

Efficiency

Bibliometrics can streamline the literature review process by identifying the most influential papers, authors and journals in a given field, reducing the time and effort required for a comprehensive review.

Real-time Insights

Bibliometric studies can provide real-time data, allowing researchers to monitor the growth and evolution of a research area continuously.

Assessment of Impact

Institutions and researchers can use bibliometrics to measure the impact of their work, aiding in evaluation and decision-making.

Identification of Collaboration Opportunities

Bibliometric data can reveal collaborative networks, helping researchers identify potential collaborators in their field.

In summary, while conventional literature reviews remain valuable for qualitative insights and in-depth understanding, bibliometric studies offer a data-driven, quantitative and efficient approach to complement these conventional methods. They are particularly suitable for researchers looking to gain a broader perspective on the existing body of literature, assess research impact and track trends in a systematic and objective manner (Taylor, 2012) (Cook and Leviton, 1980) (Paul and Barari, 2022). When combined, these approaches can enhance the rigor and comprehensiveness of research and decision-making in various fields as Figure 2 provides a clear and concise overview of the strengths and benefits of both conventional literature reviews and bibliometric studies in a schematic manner. In this paper, we have discussed a case study regarding a real-life problem with

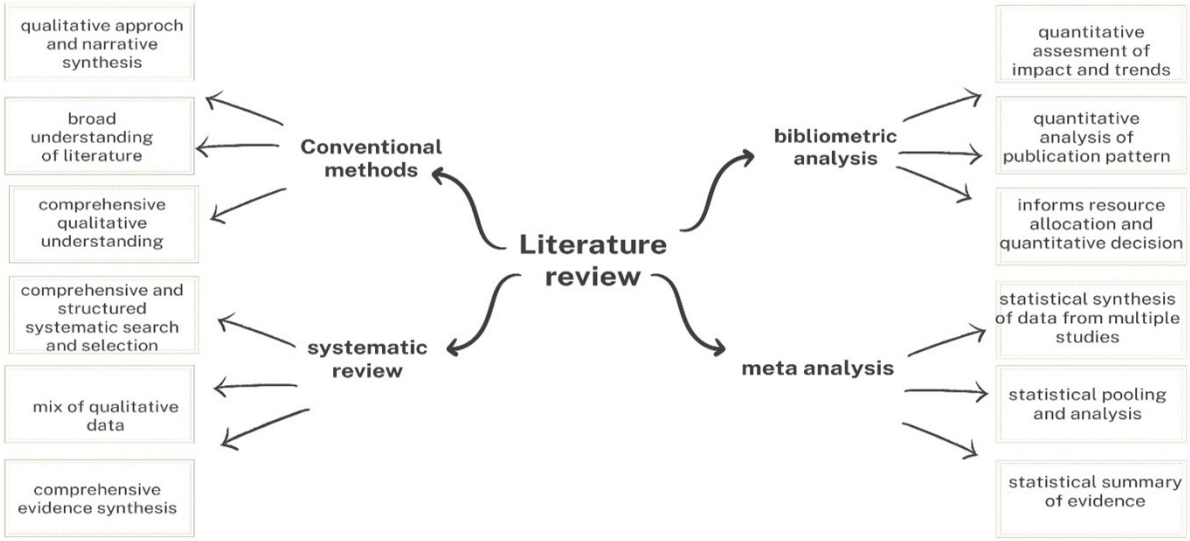

Figure 1: Characteristics tree map of different literature review methods.

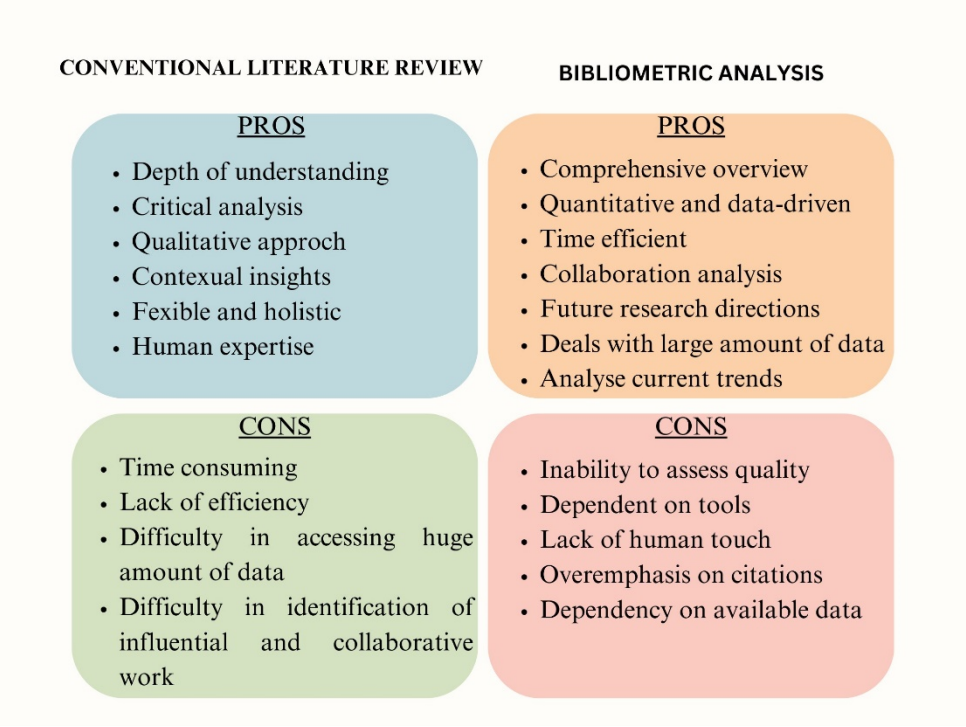

Figure 2: Pros and Cons of Conventional Literature Review and Bibliometric analysis.

the help of bibliometric analysis. In the pursuit of sustainable development and management of resources, there is a growing global research trend to explore innovative solutions for addressing environmental challenges. One such area of interest is the sustainable recovery of nutrients from urine, a valuable yet often overlooked resource. Through bibliometric analysis, we have aimed to identify research trends, seminal works and emerging research themes within the field of nutrient recovery from urine.

MATERIALS AND METHODS

An approach to conducting a literature review through Bibliometrics involves using quantitative analysis and data-driven techniques to systematically evaluate and synthesize existing scholarly literature on a particular topic or research question. In addition to providing qualitative insights and in-depth knowledge, conventional literature reviews may still be complemented by bibliometric studies, which provide a data-driven, quantitative and effective approach. To conduct an objective and data enriched bibliometric study, the identification of the source of metadata or database and analytical tools must be of high quality and reliability for its bibliographic extraction (Herrera-Franco *et al.*, 2020). Some of globally established databases, data analytics tools and visualization tools used in bibliometrics are discussed below.

Databases

Databases are organized collections of scholarly and academic information that are designed to be easily accessed, managed, updated and are designed to store, organize and provide access to a vast array of research papers, articles, conference proceedings and other academic materials. Academic databases cover a wide spectrum of disciplines, allowing researchers and academics to explore literature relevant to various fields of study and facilitates interdisciplinary research and encourages collaboration between different academic domains. Key databases include:

Google Scholar

A free search engine offering scholarly articles, theses, books and patents across various disciplines, with user-friendly citation tracking (Gusenbauer, 2018).

PubMed

Managed by the National Centre for Biotechnology Information (NCBI), this database specializes in biomedical and life sciences literature, essential for clinical and biomedical research (Lu, 2011).

IEEE Xplore

A comprehensive resource for electrical engineering and computer science, offering extensive academic content in these fields (Reed and Yu, 1990).

JSTOR

A digital library hosting a diverse collection of academic journals, books and primary sources, valuable for multidisciplinary research (Ansari and Raza, 2018).

ERIC (Education Resources Information Centre)

Focused on education literature, including journal articles, reports and conference papers to support education research (Jatkevicius and Sebold, 2000).

ScienceDirect

A leading full-text scientific database covering a wide range of disciplines with access to high-impact journals and articles (Potier *et al.*, 2014).

Scopus[https://www.Scopus.com/] and Web of Science[https://www.webofscience.com/wos] are often selected mostly because of its high standards of quality, extensive coverage of information gathering (with 1.7 billion cited references as of right now, extending back to 1970), ease of data download and superior coverage of publications(Herrera-Franco *et al.*, 2020) (Malanski *et al.*, 2021). A significant proportion of publications linked to WoS and Scopus that are connected to the meta-analysis are also investigated in the research conducted by (Zhu and Liu, 2020). That is to say, in addition to being extensively utilized in bibliometric-related research, WoS and Scopus are also extensively employed in meta-analysis-related research, particularly in China. Further, WoS and Scopus both are consulted by researchers from a growing range of knowledge fields of study such as information science, library science and health and medical sciences. Scopus, while less capable than some specialized databases, allows patent searches through Lexis-Nexis (Kulkarni, 2009). The Institute for Scientific Information (ISI), founded by Eugene Garfield in 1956, has long been a leading authority in assessing journal papers using its database, which includes approximately 9,300 top-ranked scientific journals across 256 fields. The Impact Factors from ISI are a standard for journal evaluation. Scopus, gaining academic relevance in recent decades, supports various export file formats like CSV, BibTeX, ASCII and RIS, each catering to different needs in bibliographic data management (Guz and Rushchitsky, 2009; Kamboj and Sudhir Kumar Tyagi, 2024; Burnham, 2006; Brij Mohan Gupta *et al.*, 2024) .

Web of Science, owned by Clarivate Analytics PLC, is a widely respected database, covering 79 million core collection records (Matthews, 2021). The rise of databases like Scopus and Web of Science has simplified access to bibliometric data (Donthu *et al.*, 2021; Vieira and Gomes, 2009). Web of Science uses citation indexing and cross-disciplinary search tools, allowing users to trace an idea's influence and visualize trends (Reuters, 2010).

Comparative research by Mongeon and Paul-Hus (2016) highlights differences between Scopus and Web of Science, noting that while most Web of Science journals are in Scopus, Scopus covers more exclusive journals, especially outside Natural Sciences and Engineering (de Moya-Anegón *et al.*, 2007; Vieira and Gomes, 2009). Scopus also offers about 20% more citation coverage than Web of Science, though it only includes publications post-1995 (Falagas *et al.*, 2008; Chadegani *et al.*, 2013; Singh *et al.*, 2021). This makes Scopus a valuable complement to other databases in research.

For this study, Scopus and Web of Science are chosen as databases because of their advanced search and analytical tools that allow them to apply various filters and extract meaning and refinement from the data unlike other mentioned databases and comprehensive coverage across a wide range of academic disciplines, making them suitable for multidisciplinary research. This is in contrast to specialized databases like IEEE Xplore, which is focused on electrical engineering and computer science, or PubMed, which primarily covers biomedical and life sciences literature. Features these two databases contain that are exclusively helpful for this study are:

Structured nature

- High-Quality Content,
- Comprehensive coverage,
- Citation tracking,
- Keyword indexing,
- Global reach,
- Author and affiliation indexing,
- Self-visualization and analysis,
- Monitoring scholarly communications,
- Regular updates and maintenance,
- Integration with research management and reference management tools.

Also, Scopus and Web of Science are pivotal in bibliometric research, offering comprehensive bibliographic data and robust tools for citation analysis. These databases are instrumental for tracking citations, assessing the impact of research, evaluating the productivity and collaboration patterns of authors and institutions and also provide valuable insights into emerging research trends and facilitate quality assurance through their rigorous editorial standards, making them indispensable for bibliometric analyses, research assessment and informed decision support in academia and research policy. The abovementioned databases are discussed below in detailed manner.

Software and tools

Visualization and data analytics tools are crucial for researchers and institutions, enabling sophisticated analyses of scholarly output (Quessy and Bahraoui, 2013). Bibliometric software like Gephi, Leximancer, VOSviewer and CiteSpace has sparked significant interest in bibliometric analysis (Donthu *et al.*, 2021). Gephi focuses on network analysis, while Leximancer specializes

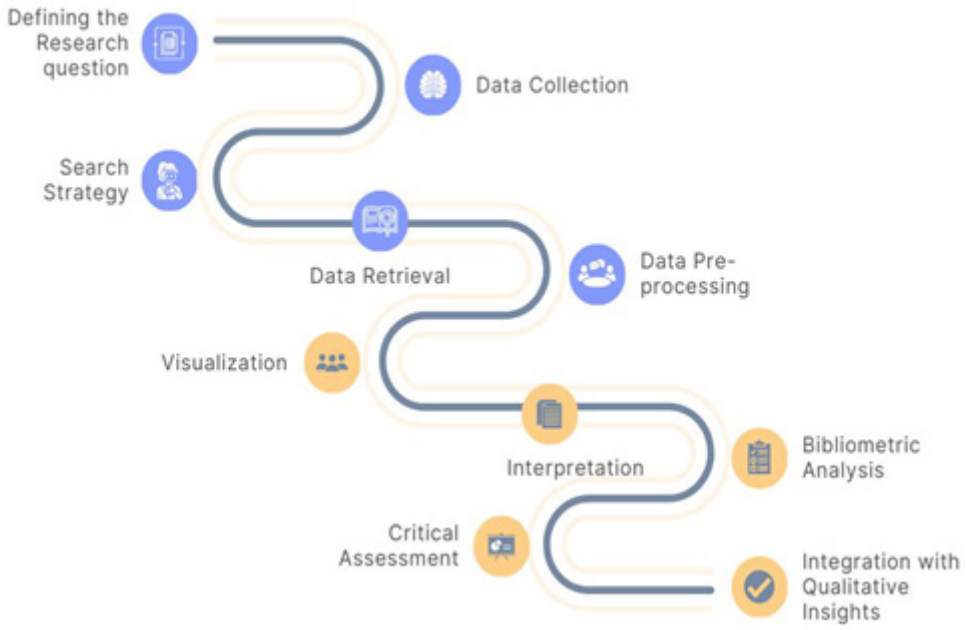

Figure 3: Workflow of Bibliometrics.

in text analytics. CiteSpace, designed for in-depth literature analysis, excels at identifying emerging trends and patterns, visualizing co-citation networks and keyword co-occurrence (Chen, 2006; 2016).

Tools like InCites, integrated with Web of Science and Dimensions Analytics provide interactive visualizations for citation analyses and research impact assessments. Sci2 Tool offers open-source bibliometric and scientometric analysis, using visualizations like temporal trend charts and geospatial maps. Bibexcel, though less feature-rich, is a valuable no-cost option for processing and analysing bibliographic data (Persson *et al.*, 2009; Cobo *et al.*, 2011). Python libraries such as Matplotlib and Seaborn further enhance data exploration, offering flexibility in creating customized visualizations.

VOSviewer [http://www.vosviewer.com/journalmap/;http://www.vosviewer.com/] stands out for bibliometric analysis, offering tailored visualizations of co-authorship, co-citation networks and term maps. Its user-friendly interface and focus on bibliometric data make it particularly suited for academic research, providing comprehensive insights into the structure of scientific fields and research trends. In the scientific field, VOSviewer proves valuable for initiatives requiring a nuanced understanding of scholarly landscapes. It facilitates the identification of trends, contributors and thematic clusters within vast bibliographic datasets. VOSviewer's effectiveness aligns with the scientific rigor demanded in bibliometric studies (van Eck and Waltman, 2009; Yu *et al.*, 2020), making it a useful instrument for unravelling the intricate tapestry of scholarly communication.

Data analytical tools have become essential for visualizing and interpreting statistical data, helping researchers convert raw data into actionable insights. Platforms like Python and R, integrated with visualization libraries such as Matplotlib, Seaborn, ggplot2 and Plotly, have gained popularity for their powerful data analysis capabilities (Stančin and Jović, 2019; Nelli, 2015). SPSS, developed in the 1960s and now owned by IBM, is widely used in social sciences for statistical analysis, including regression and hypothesis testing. Microsoft Power BI enables users to transform raw data into meaningful insights through interactive reports (Becker and Gould, 2019).

OriginPro, chosen for its extensive graphing capabilities and advanced statistical features like hypothesis testing, is popular in scientific research, engineering and data analysis (Abdullah and Khairurrijal, 2016). It offers a wide range of analytical tools, including curve fitting, statistical analysis and customizable data fitting algorithms, making it highly versatile for researchers (Guzelgulgen *et al.*, 2021; Seifert, 2014; Stevenson, 2011). OriginPro's ability to handle large datasets efficiently further cements its status as a leading data analysis tool.

Methodology: Workflow of Bibliometrics

As the flowchart in Figure 3 below explains itself, the bibliometric methodology encapsulates the application of quantitative techniques bibliometric analysis through performance analysis (publication and citation related), scientific mapping (citation, co-citation analysis, bibliometric coupling, co-word and co-authorship analysis) and network analysis (network metrics, clustering, visualization) (Donthu *et al.*, 2021b;Kamboj and Sudhir Kumar Tyagi, 2024). The detailed parameters of the data analysis step are enlisted below.

- Publication trends,

- Author analysis,
- Journal analysis,
- Citation analysis,
- Keyword analysis,
- Co-citation analysis,
- Network analysis.

In the further part of the paper, a case study is presented as per the methodology explained above to attain country wise trend analysis, co-authorship networks and various bibliometric analysis on 'nutrient recovery from urine' and exploration of the sustainable approaches related to the topic.

Case Study

This case study presents a comprehensive bibliometric analysis of literature pertaining to urine in the context of nutrient recovery and waste management. Urine, conventionally considered a waste product, has gained increasing attention as a valuable resource for sustainable nutrient recovery (Rahman *et al.*, 2014) (Rahman and Chariar, 2016) (Rahman, 2016) (Simha and Ganesapillai, 2017) (Udert and Wächter, 2012) In the field of sustainable wastewater management, ongoing research endeavours are dedicated to the elucidation and optimization of nutrient recovery processes from urine, with a particular emphasis on struvite recovery. Struvite, a crystalline compound composed of magnesium, ammonium and phosphate, represents a coveted resource due to its potential as a slow-release fertilizer (Rahman and Chariar, 2015) (Sakthivel *et al.*, 2020). Technologies are being employed to harness the inherent nutrient richness of urine, employing methods such as precipitation and crystallization to selectively extract phosphorus and nitrogen compounds. Diverse strategies encompassing ion exchange, membrane technologies and electrochemical approaches are being explored for their efficacy in nutrient recovery. The interdisciplinary nature of this research underscores a holistic approach towards sustainable resource management, accentuating the importance of maximizing nutrient recovery from urine while mitigating environmental impacts. The scientific community across the world has been actively engaged in advancing these methodologies, aiming to bridge the gap between theoretical insights and practical implementation (Alemayehu *et al.*, 2020). Utilizing Scopus as a robust database, providing Interdisciplinary and global Coverage, this analysis offers a comprehensive overview of research output, geospatial distribution and collaboration networks.

Methodology

The research question, focusing on trends in nutrient recovery and sustainable waste management using urine, was formulated based on insights from existing literature. Prior studies highlight the environmental impacts of conventional wastewater treatment and the need for sustainable alternatives. This research aims to address gaps in the literature by examining research trends, geographical distribution and thematic focuses within the field.

As illustrated in Figure 4, Data collection was conducted using Scopus with keywords like "urine," "nutrient recovery," "struvite recovery," and "sustainable waste management." Initial searches yielded 406,557 documents for "urine," 3,933 for "nutrient recovery," and 1,016 for "struvite recovery." The search was refined to include peer-reviewed articles, reviews and conference papers published between 2000 and 2023, focusing on subject areas such as Environmental Science, Engineering, Chemical Engineering, Energy and Agriculture and Biological Sciences. Medical aspects of urine were excluded to concentrate on sustainable nutrient recovery.

For String 1 ("urine AND waste AND management"), the initial 555 documents were filtered down to 412, considering the year range, language, subject areas and document types. For String 2 ("struvite AND recovery AND urine"), the initial 243 documents were narrowed to 108 after similar filtering.

Overall, starting from an initial 798 documents, the PRISMA 2020 flow diagram helped refine the selection to 520 documents through a step-by-step filtering process based on year, language, subject area, document type and abstract relevance.

Interpretation

A refined form of bibliometric data has been analysed and visualized by several data analytical tools and conclusion has been made that the emerging work on urine in waste management and nutrient recovery has been trending since the last decade. From Figure 5(A) formed respectively with the combined final data of string 1 and 2, it can be interpreted that there is a general upward trend in the number of keywords from 2006 to 2023, with some fluctuations. The years 2020 have the highest frequency of keywords, with 30 and 14 occurrences respectively, suggesting a recent peak in activity or interest. The trend of struvite recovery can be clearly visualized, that the period from 2010 to 2014 shows a relatively low number of frequency, with a significant increase starting from 2015.The early 2000s and the late 2000s show very few keyword occurrences, with some years only having 1 or 2 instances but a relevant peak can be observed at 2004 to 2005.

According to the graphs obtained by the analysis of country or territory involved in research publication in the respective topic, Figure 5(B) are interpreted that the study started from 2000s and took a leap on 2006 especially in United States in areas like Environmental science and agricultural technology as it holds approximately 14.86% to 15% of the total documents, making it the top country in this database. China and European countries have joined the trend which gave the study a huge leap in the last decade. China has been the most focussed country in Struvite recovery research and industrialization of it is the second leading

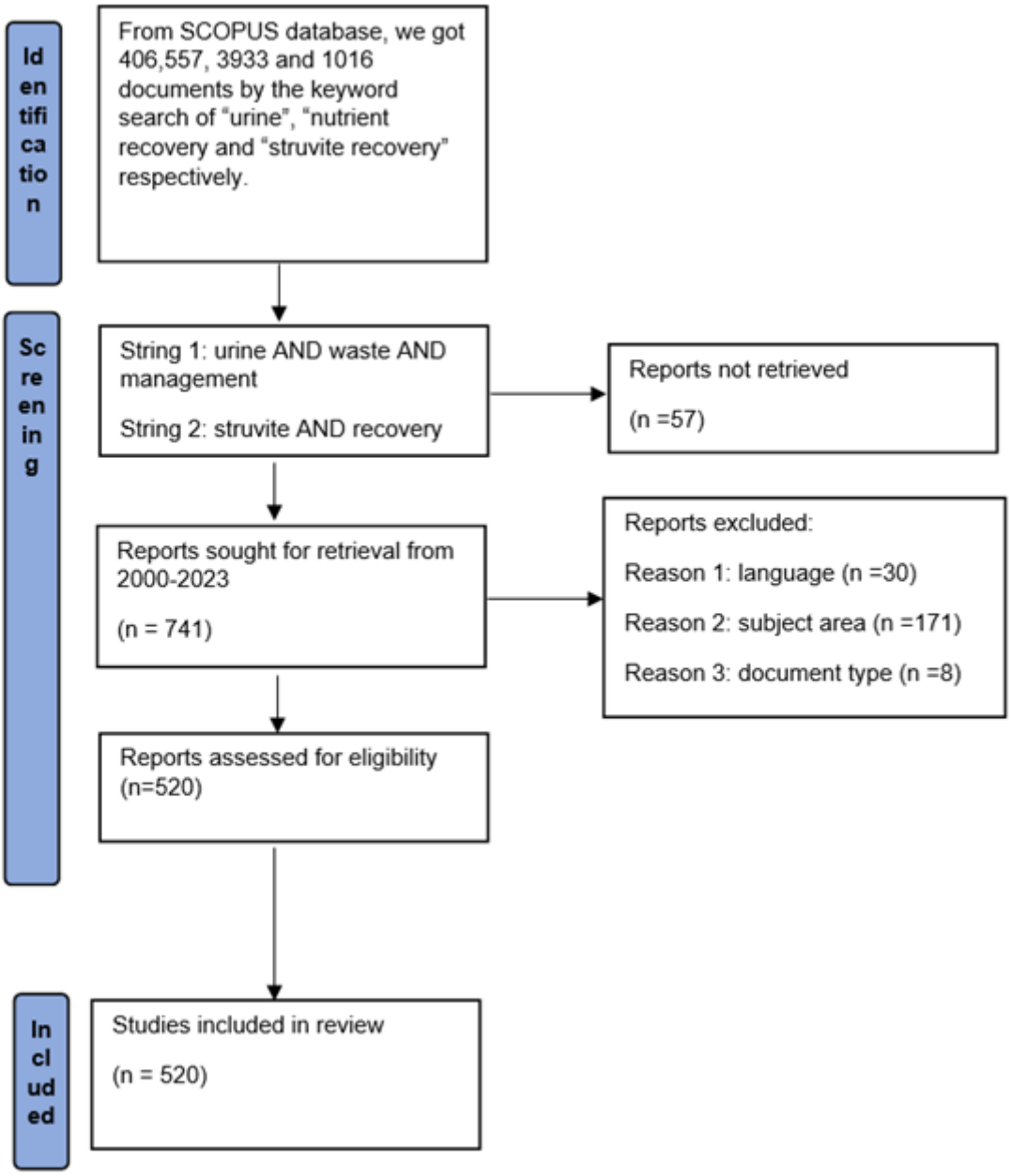

Figure 4: PRISMA 2000 Diagram Flow.

country to have 27% of the total Struvite recovery research. The United States has been leading the study in sustainability and waste management perspective as EPA, Environmental Protection Agency has been very active and over 50 years, dozens of laws and acts have been passed. On the other hand, China has focussed more on nutrient recovery aspect of urine utilization. As it is also evident from co-authorship and citation networks and densities of countries, the top 5 countries by number of research documents are the United States, China, Switzerland, Germany and Sweden. And among all the recovery methods, struvite recovery has been the top choice of scientists and trending throughout the decade. Also, from Figure 5(C) we get that 'Water research', 'Water science and technology' and 'Science of Total Environment' have been the leading sources from the past few decades, which is also very evident from the Figure 5(E) citation source density. According to comparative analysis of two strings in Figure 5(D) through the subject areas implied in the refinement, we get that 'Environmental Science' leads with a significant margin, comprising over 53% of the total keywords and documents. Engineering and chemistry follow with nearly 15% and the remaining subject areas each hold less than 10% of the total keywords, with Agricultural and Biological Sciences having the least at 2%.

From further analysis, we can conclude that research and study in the topic of nutrient recovery and its sustainable application have

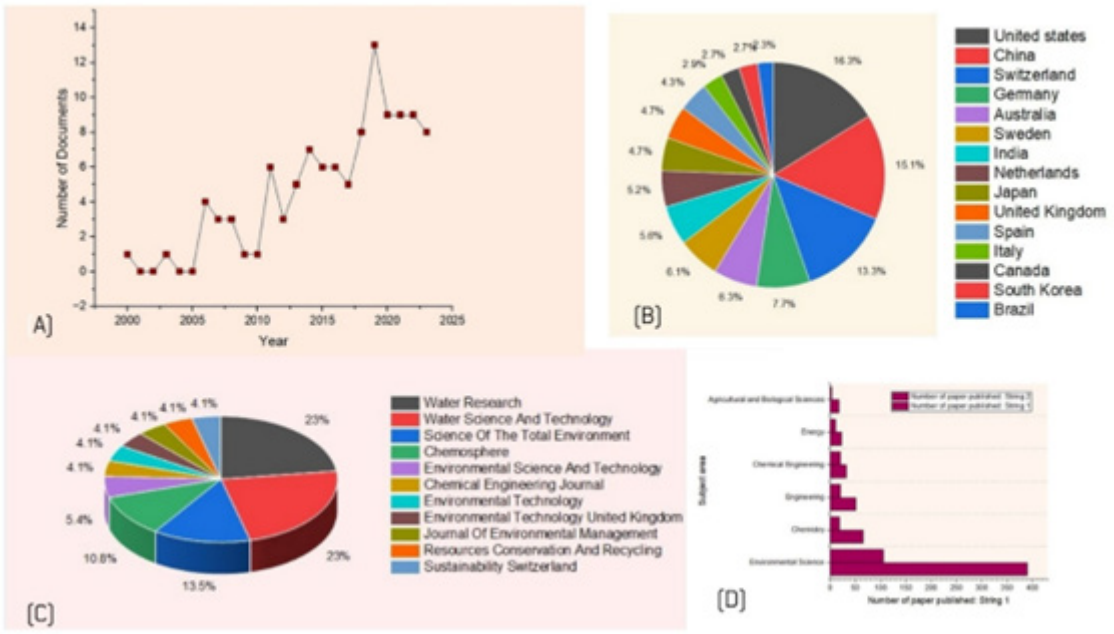

Figure 5: Visualisation of data retrieved from Scopus by OriginPro; (A) Year wise Analysis of publication statistics; (B) Global distribution of publication; (C) publication statistics on basis of source; (D) Subject area vs Number of paper published (String 1 and 2).

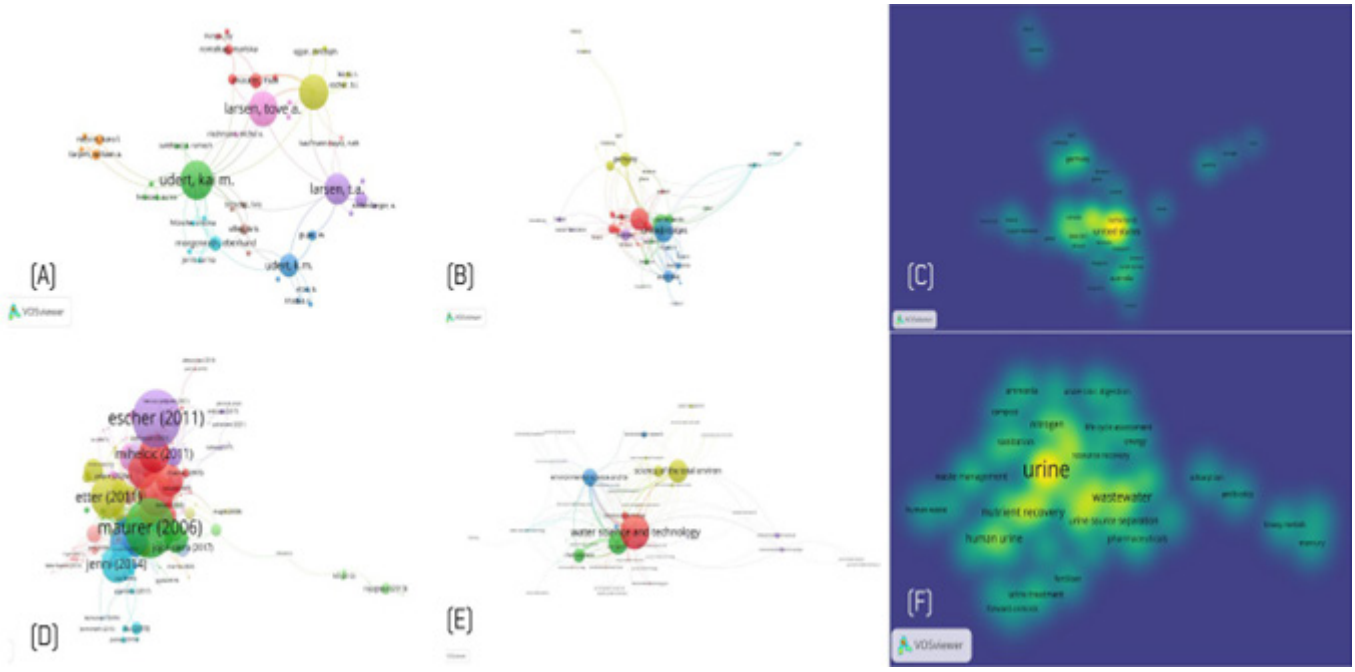

Figure 6: Co-Authorship and Citation Networks by VOSviewer; (A) co-authorship network between authors; (B) co-authorship network between countries; (C) co-authorship density between countries; (D) citation network of authors; (E) citation network of publication sources; (F) author keyword density network.

been trending and serious work is going on all over the world nut still many aspects such as addressing global challenges through this sustainable approach and opportunities for interdisciplinary collaboration and knowledge sharing are still under progress and need serious concentration of the academic world. The increasing trend in research on nutrient recovery and sustainable application is driven by a growing awareness of the environmental impact of traditional wastewater treatment, the need for resource conservation and alignment with global sustainability goals. Technological advancements, economic incentives and opportunities for interdisciplinary collaboration further fuel this interest. Despite progress, there are ongoing challenges,

Table 1(A): Authors Having Most Co-Authorship Link Strength.

Author	Documents	Citations	Link strength
Udert, Kai M.	9	843	23
Lienert, Judit	8	677	18
Larsen, T.A.	7	1152	16
Pronk, Wouter	4	344	10
Morgenroth, Eberhard	3	365	9
Maurer, Max	3	263	8
Otterpohl, R.	5	163	8
Boller, Markus	3	287	7

Table 1(B): Most Cited Documents.

Document	Citations	Links
Maurez (2006)	422	60
Udert (2012)	214	36
Maurer (2003)	296	31
Lienert (2010)	134	30
Etter (2011)	296	29

including the need to address global issues, develop supportive policies, increase public awareness and create economic models that highlight the benefits of nutrient recovery. Additionally, fostering interdisciplinary collaboration and continuous technological innovation are essential for advancing sustainable waste management practices and scaling solutions globally.

For further analysis, VOSviewer has been used for visualizing and exploring complex networks, such as co-authorship networks in scientific research. In VOSviewer networks, each node represents an author in the network. The size of the node often correlates with the number of publications or citations, indicating the author's productivity or impact and edges or lines between nodes represent co-authorship links. The thickness of an edge may indicate the number of co-authored works. The distance between nodes can reflect the strength of the co-authorship relationship; closer nodes may have stronger ties. Co-authorship networks of documents are retrieved as Figure 6(A) and Table 1(a) reveals the most active authors. The total network contains 10 clusters, total link strength of 728.From the co-authorship network and density network of countries as revealed in Figures 6(B) and 6(C), it has been clearly observed the evidently strong link strength between the United States and China. Other countries such as Australia, Switzerland and Spain are also connected well.

The documents having the most citation links with reference of Figure 6(D) and Table 1(b), are Maurer (2006), Udert (2012), Maurer (2003), Lienert (2010) and Etter (2011) having citation numbers of 422,214,296,134 and 296 respectively. From the citation network of document sources as visualized in Figure 6(E) reassure the previous interpretation of Figure 6(C), of 'Water science and technology' being the leading source of relevant documents and 'Water research', 'Water science and technology' and 'Environmental Science and Technology" having the most citation link strength. Additionally, author keywords having most occurrence and link strength have been revealed by Figure 6(F) to be 'urine', 'wastewater'. 'Source separation', 'wastewater treatment', 'struvite', 'nutrient recovery', 'phosphorus', 'nitrogen'.

RESULTS AND DISCUSSION

This study has underscored the increasing prominence of bibliometrics as an indispensable literature study approach in academia, emphasizing its quantitative and structured methodology. This research sheds light on the importance and application of bibliometric analysis over conventional reviewing methods and the integration of data analytics into the data visualization and data interpretation part of the research. This paper offers a more holistic approach to literature study evaluating research impact and scholarly communication with the help of a real-life problem-based case study. As bibliometrics continues to evolve, researchers and institutions should embrace these tools to improve research evaluation, foster collaboration and enhance decision-making processes.

This research also involves a real-life problem of studying research trends of sustainable nutrient recovery in a global academic perspective in which we got very précised results of research trend analysis, country-wise involvement in research, analysing top journals and subject areas relevant for the research.

This paper encourages further exploration of data analytics tools, the development of novel metrics and the integration of bibliometric analysis into the broader academic landscape. The insights presented here serve as a foundation for future research and innovation in the field of bibliometrics. The study underscores the importance of continued innovation in the field of academia data analytics tools to keep pace with the evolving landscape of bibliometrics. Also, the case study approach dealing with a real-world problem has provided a more realistic and holistic approach of the importance of bibliometrics and use of data analytics in it.

CONCLUSION

The integration of bibliometric analysis and data analytics offers a transformative approach to literature study, bridging traditional qualitative insights with quantitative rigor. By employing advanced analytical tools and methodologies, this case study demonstrates the potential to uncover hidden patterns, trends, and relationships within scholarly research. The convergence of these disciplines not only enriches the depth of academic inquiry but also fosters interdisciplinary collaboration, enabling researchers to address complex questions with precision.

Moreover, the findings highlight the significance of adopting data-driven strategies in literature studies to inform evidence-based decision-making and identify emerging research frontiers. This hybrid approach paves the way for a more nuanced understanding of academic landscapes, offering a scalable model for future explorations. As bibliometric and data analytics technologies continue to evolve, their application in literature studies is poised to redefine research paradigms, fostering innovation and inclusivity in knowledge discovery.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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