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Research Data Management in Citizen Science: A Bibliometric Analysis

C.R. Che Jaafar[1], A. Mohammed Ghazali[2*] and M.I. Ismail[3]

[1]*Faculty of Information Science, Universiti Teknologi MARA (UiTM) Selangor, Malaysia.*

[2]*Faculty of Information Science, Universiti Teknologi MARA (UiTM) Kedah, Malaysia.*

[3]*Hamzah Sendut Library, Universiti Sains Malaysia, Penang, Malaysia.*

Citizen Science (CS) is increasingly recognised in the scientific community due to its ability to generate large volumes of data that require effective management. Libraries play a vital role in supporting CS by acting as central hubs for CS programs, offering Research Data Management (RDM) services, and providing training for researchers and citizen scientists. This paper examines research trends in RDM and CS through a bibliometric analysis of 1,439 publications retrieved from the Scopus database between 2008 and 2024. The data were analysed using Microsoft Excel and Harzing's Publish or Perish. Results showed that journal articles were the most common publication type, with English as the predominant language. *Biological Conservation* emerged as the most influential journal, while "Citizen Science" was the most frequently used keyword, followed by "RDM", "Biodiversity and Conservation", and "Data Quality Control". Scientific disciplines dominated the publication output, particularly after 2021. Callaghan, C.T., was identified as the most productive author, with the United States leading in contributions and the Center National de la Recherche Scientifique being the top institution. A total of 31,544 citations were recorded. This study provides valuable insights for researchers, librarians, policymakers, and funding bodies to explore emerging trends, collaboration opportunities, and strategic directions in CS research.

Keywords: citizen science; research data management; academic libraries; bibliometrics

I. INTRODUCTION

Citizen science (CS) is a collaborative research approach in which professionals and the public generate authentic scientific data (Bonney *et al.*, 2014; Bedessem *et al.*, 2021). As a key driver of open science, CS enhances data accessibility and quality, but its success depends on consistent, well-documented data management, particularly when non-professionals collect data (Finkel *et al.*, 2020; Thuermer *et al.*, 2023). Research Data Management (RDM) practices in CS must address challenges such as locating data, working with diverse populations, and handling sensitive information (Hansen *et al.*, 2020). The CS data life cycle from planning to preservation demands systematic management to ensure trust, quality, and reusability (Fraisl *et al.*, 2022). By democratising science, CS fosters public engagement, equitable data access, and environmental awareness, making practical RDM essential (Shwe, 2020).

Libraries now play a vital role in managing, preserving, and disseminating research data from both researchers and citizen scientists, ensuring data longevity, accessibility, and adherence to the FAIR (Findable, Accessible, Interoperable and Reusable) principle for reproducibility (Ismail *et al.*, 2022). In CS, libraries collaborate with stakeholders to support community engagement, provide data management training, and promote open access and data ethics (Che Jaafar *et al.*, 2024; Martek *et al.*, 2022). Recent literature highlights CS's growing presence across fields such as hydrology, ecology, energy, and education through bibliometric analyses using tools like VOSviewer and

*Corresponding author's e-mail: asmadi615@uitm.edu.my

databases such as WOS and Scopus. Studies by Alfaro-Ponce *et al.* (2024) and Castagneyrol *et al.* (2023) revealed CS's integration into education and ecology, while noting limitations, such as regional biases and inconsistent use of CS labels in ecological research, which may affect literature coverage and thematic analysis.

Several studies have mapped the growth of CS literature through bibliometric analysis. Barui and Mazumder (2023) examined CS research trends, author collaborations, and international partnerships, while Pelacho *et al.* (2021) explored collaborative networks and publication patterns across disciplines. Chaubey and Singh (2021) analysed publication volumes, research areas, and co-authorship networks in WOS-indexed journals. Meanwhile, Bautista-Puig *et al.* (2019) investigated the academic and societal impact of CS, focusing on thematic and geographical distributions. Additionally, studies by Odenwald (2018), Kullenberg and Kasperowski (2016), and De Filippo *et al.* (2020; 2021) offered insights into CS's dissemination, concepts, and methodologies across various fields.

II. METHODS

Data for this study were sourced from the Scopus database due to its extensive, high-quality, and interdisciplinary coverage, well-suited to the CS and RDM fields (Zhang & Eichmann-Kalwara, 2019; Baas *et al.*, 2020). Its rigorous indexing, global accessibility, and diverse publication range provide a solid foundation for a comprehensive and reliable analysis of research trends (Martin-Martin *et al.*, 2021; Wahid *et al.*, 2020). This study applied inclusive criteria to capture diverse CS and RDM literature across various languages, source types, and document types. On 20 December 2024, a Scopus search using the keywords "citizen science" and "data" in titles, abstracts, and keywords yielded 1439 usable records, as illustrated in Figure 1. The search strategy was TITLE-ABS-KEY ("citizen science") AND KEY ("citizen science") AND KEY ("data"). Following the literature search, publication data were extracted from Scopus in RIS and CSV formats. The data were analysed using Microsoft Excel (for publication statistics and visualisations) and Harzing's Publish or Perish (for citation analysis), employing widely recognised bibliometric tools.

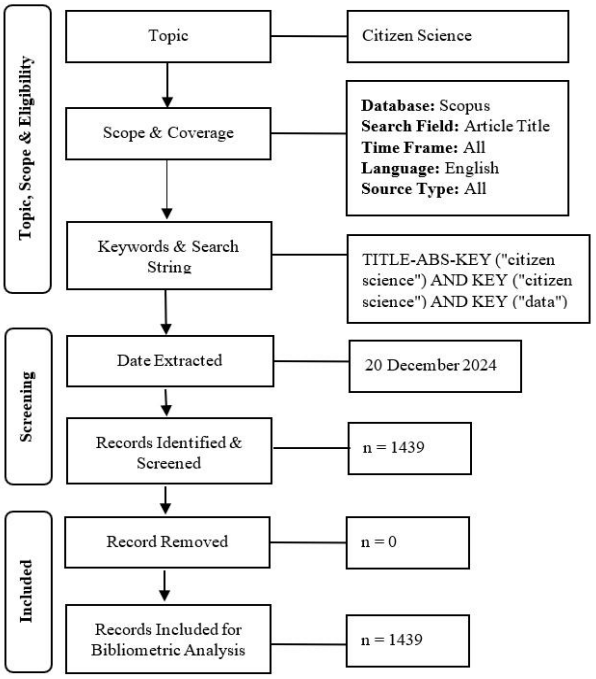

Figure 1. Flow diagram of the search strategy (adapted from Zakaria *et al.*, 2020)

III. RESULTS

The analysis of the academic work extracted throughout the search process was based on the following: document types; the most active source titles of CS publications; keywords; subject areas; research trends; authorship analysis; and citation analysis.

A. Document Types and Preferred Source Titles of CS Publication

The analysis of document types, summarised in Table 1, reveals that articles and conference papers constitute the majority, accounting for 64.84% and 24.11% of the total publications, respectively. Review articles (6.32%) and data papers (0.42%) highlight the significance of synthesising existing knowledge and facilitating data sharing. The low number of books (0.14%) and book chapters indicates that most knowledge dissemination occurs through journal articles and conference papers. Despite their lower representation, notes, editorials, letters, and short surveys (0.63%, 0.56%, and 0.28%, respectively) also contribute valuable insights into specific issues within the field.

Table 1. Document Type

Document Type	Total Publications	Percentage (%)
Article	933	64.84
Conference Paper	347	24.11
Review	91	6.32
Book Chapter	35	2.43
Note	9	0.63
Editorial	8	0.56
Data Paper	6	0.42
Letter	4	0.28
Short Survey	4	0.28
Book	2	0.14
Total	**1439**	**100.00**

Results of the most active source in Table 2 show that 'Biological Conservation' leads with 30 publications, followed by 'Proceedings of Science' (26) and 'Science of the Total Environment' (22). Other notable sources include 'Lecture Notes in Computer Science' (21). 'Marine Pollution Bulletin' (20), and 'PLOS ONE' (19). Prominent conference proceedings, such as Conference on Human Factors in Computer Systems Proceedings (18), CSCW (17), and CEUR (16), also feature prominently, highlighting the diverse and interdisciplinary contributions of computer science across various fields.

Table 2. Most active source titles with a minimum of 15 publications

Source Type	Total Publications
Biological Conservation	30
Proceedings of Science	26
Science of the Total Environment	22
Lecture Notes in Computer Science, Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	21
Marine Pollution Bulletin	20
PLOS ONE	19
ACM International Conference Proceeding Series	18
Citizen Science Theory and Practice	18
Conference on Human Factors in Computing Systems Proceedings	18
Diversity and Distributions	17
Proceedings of the ACM Conference on Computer-Supported Cooperative Work (CSCW)	17
Sustainability Switzerland	17
CEUR Workshop Proceedings	16
International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences ISPRS Archives	16

As shown in Table 3, there are 1440 publications, some of which may have been recorded in multiple languages. Most are in English (1415 or 98.26%), while other languages like Spanish, German, Chinese, French, and Portuguese have only 3 to 6 each. Finnish, Hungarian, Italian, and Russian each have just one.

Table 3. Languages

Language	Total Publications	Percentage (%)
English	1415	98.26
Spanish	6	0.42
German	5	0.35
Chinese	4	0.28
French	3	0.21
Portuguese	3	0.21
Finnish	1	0.07
Hungarian	1	0.07
Italian	1	0.07
Russian	1	0.07
Total	**1440**	**100.00**

B. Keywords

Scopus keywords cover multiple fields, including author keywords, index terms, trade names, and chemical names. Based on Table 4, 'Citizen Science' is the most common keyword, found in 1352 publications. Other frequent keywords include 'Data Acquisition' (185), 'Data Quality'

(173), 'Crowdsourcing' (164), and 'Environmental Monitoring' (151), 'Data Set' (149), 'Data Collection' (126), 'Climate Change' (84), and 'Big Data' (73) show strong research interest in environmental and data-related topics in RDM and CS.

Table 4. Keywords

Author Keywords	Total Publications
Citizen Science	1352
Data Acquisition	185
Data Quality	173
Crowdsourcing	164
Biodiversity	163
Environmental Monitoring	151
Data Set	149
Data Collection	126
Climate Change	84
Information Processing	77
Monitoring	77
Big Data	73
Procedures	72
Open Data	67

C. Subject Areas

Subject area analysis uses Scopus's All Science Journal Classification Codes (ASJC). As shown in Table 5, scientific fields have more publications than non-scientific ones. Environmental Science leads with 560 publications (7.55%), followed by Computer Science (397) and Agricultural and Biological Sciences (396). Among non-scientific fields, Social Sciences is the highest with 238 publications (3.21%), followed by Multidisciplinary studies (88).

Table 5. Subject Areas

Subject Area	Total Publications	Percentage (%)
Environmental Science	560	7.55
Computer Science	397	5.35
Agricultural & Biological Sciences	396	5.34
Social Sciences	238	3.21
Earth and Planetary Sciences	221	2.98
Engineering	144	1.94
Multidisciplinary	88	1.19
Medicine	75	1.01
Mathematics	73	0.98
Physics and Astronomy	69	0.93
Biochemistry, Genetics & Molecular Biology	68	0.92
Decision Sciences	46	0.62
Energy	44	0.59
Arts and Humanities	41	0.55
Business, Management & Accounting	25	0.34
Materials Science	17	0.23
Chemistry	16	0.22
Neuroscience	16	0.22
Immunology and Microbiology	14	0.19
Chemical Engineering	13	0.18
Pharmacology, Toxicology & Pharmaceutics	13	0.18
Economics, Econometrics & Finance	7	0.09
Psychology	6	0.08
Veterinary	5	0.07
Health Professions	4	0.05
Nursing	4	0.05

D. Publications

As shown in Figure 2, publications in RDM and CS steadily increased from 2008 to 2024. The highest output was in 2021 (194 publications), followed by 2022 (190) and 2023 (186). Notably, growth accelerated after 2012, following a period of low publication volume from 2008 to 2010.

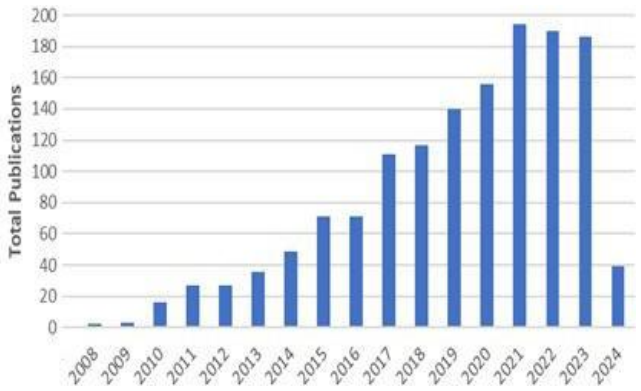

Figure 2. Publications

Table 6 shows that the United States leads in RDM and CS publications with 519 (7.00%), followed by the UK (283) and Germany (153). European countries collectively contribute a significant share, indicating strong regional involvement. Australia (126) and Canada (109) also show notable contributions. While countries like Brazil (44) and China (38) have smaller outputs, contributions from Africa, Asia, and Oceania reflect global interest, with Europe and North America as the main contributors.

Table 6. Countries contributed to the publications

Country	Continents	Total Publications	Percentage
United States	North America	519	7.00
United Kingdom	Europe	283	3.82
Germany	Europe	153	2.06
Australia	Oceania	126	1.70
Canada	North America	109	1.47
Netherlands	Europe	108	1.46
Italy	Europe	104	1.40
Spain	Europe	88	1.19
France	Europe	82	1.11
Switzerland	Europe	64	0.86
Brazil	South America	44	0.59
Sweden	Europe	44	0.59
Austria	Europe	41	0.55
Belgium	Europe	41	0.55
China	Asia	38	0.51
Finland	Europe	36	0.49
Norway	Europe	32	0.43
Denmark	Europe	31	0.42
South Africa	Africa	29	0.39
Greece	Europe	28	0.38

Table 7 lists the top institutions in RDM and CS with at least 20 publications. CNRS (France) leads with 48 (0.65%), followed by University College London (30), and both the UK Centre for Ecology & Hydrology and University of Oxford (29 each). The University of Florida (27), Cornell Lab of Ornithology (24), and Cornell University (23) reflect strong U.S. involvement, particularly in ornithology. Other key contributors include Oregon State University, Sveriges Lantbruksuniversitet, and Wageningen University (23 each), as well as the University of Washington and University of Queensland (22 each). The Muséum National d'Histoire Naturelle (21) highlights the role of museums in this field.

Table 7. Most influential institutions with a minimum of 20 publications

Institutions	Total Publications	Percentage
Centre National de la Recherche Scientifique (CNRS)	48	0.65
University College London	30	0.40
UK Centre for Ecology & Hydrology	29	0.39
University of Oxford	29	0.39
University of Florida	27	0.36
Cornell Lab of Ornithology	24	0.32
Cornell University	23	0.31
Oregon State University	23	0.31
Sveriges lantbruksuniversitet	23	0.31
Wageningen University & Research	22	0.30

University of Washington	22	0.30
The University of Queensland	22	0.30
Museum National d'Histoire Naturelle	21	0.28

E. Authorship

Based on Table 8, the analysis of the most productive authors in the field of RDM in CS indicates that Callaghan, C.T., is the most prolific author with 17 publications (0.23%), followed by See, L., and Wiggins, A., each with 14 publications (0.19%). Other authors who contributed significantly include Fink, D., with 12 publications (0.16%), Hochachka, W.M., and Kelling, S., each with 11 publications (0.15%). Authors such as Fritz, S., Haklay, M., and Lukyanenko, R. have each published ten articles (0.13%).

Table 8. Most 20 Productive Authors

Author	**Total Publications**	**Percentage (%)**
Callaghan, C.T.	17	0.23
See, L.	14	0.19
Wiggins, A.	14	0.19
Fink, D.	12	0.16
Hochachka, W.M.	11	0.15
Kelling, S.	11	0.15
Fritz, S.	10	0.13
Haklay, M.	10	0.13
Lukyanenko, R.	10	0.13
Crowston, K.	9	0.12
Parsons, J.	9	0.12
Bowser, A.	8	0.11
Isaac, N.J.B.	8	0.11
Johnston, A.	8	0.11
Roy, D.B.	8	0.11
Brovelli, M.A.	7	0.09
Fortson, L.	7	0.09
Fraisl, D.	7	0.09
Preece, J.	7	0.09
Schade, S.	7	0.09

F. Citation Analysis

Table 9 summarises brief citation metrics for the 16 years from 2008 to 2024. During this period, 31,544 citations were received, with an average of 1433.82 citations per year, and the average citation for each paper was 21.92. However, 1,153 published papers received at least one citation, while 286 papers have not received any citations.

Table 9. Citation Metrics

Citation years	2008-2024
Citations received	31544
Cites/Year	1433.82
Cites/Paper	21.92
Papers with citations	1153
Papers with zero citations	286

Figure 3 displays the top 20 highly cited articles. The author with the most citations is Goodchild, with 3,270, followed by Sullivan *et al.* (2009) with 1,197 and Sullivan *et al.* (2014) with 613. Authors such as M. Haklay and Sui *et al.* contributed 527 and 485 citations, respectively. The other authors demonstrate a lower yet still significant number of citations, ranging from 362 to 187. This figure provides an overview of each author's academic impact, measured by the citations received for their work.

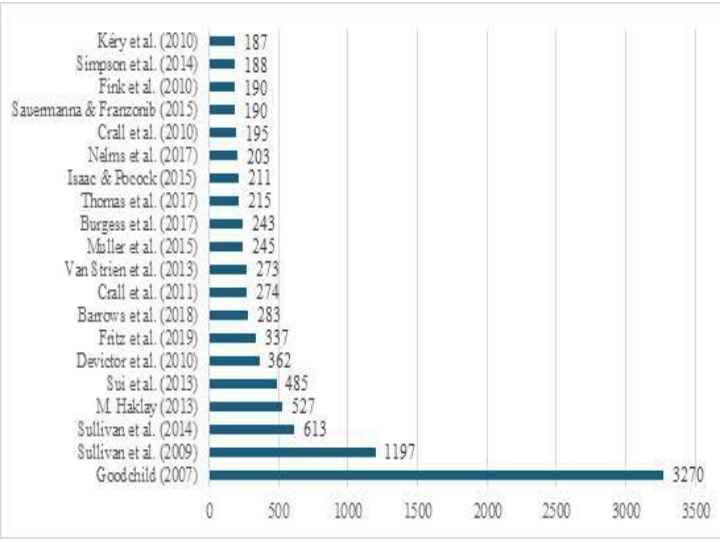

Figure 3. Top 20 Highly Cited Articles

IV. DISCUSSION

This section synthesises the findings of the study. The analysis of language in the publication reveals that this field is predominantly concentrated within the research community that primarily uses English, potentially restricting engagement and accessibility for researchers who rely on other languages. Accordingly, we identified 'Biological Conservation' as the most influential journal, publishing the most articles and demonstrating significant interest in biodiversity conservation through CS. The findings about three clusters support this: "RDM", "Biodiversity and Conservation", and "Data Quality Control". A Barui (2023) study asserted that most publications are from multidisciplinary journals. However, RDM and CS have also been discussed in multidisciplinary and environmental contexts, demonstrating the diversity and significant contributions of CS across various research fields (Tauginienė *et al.*, 2020). Meanwhile, the result regarding country-wise scientific output revealed that the US was the most active country in producing CS research. It reflects the findings of a couple of studies (Barui, 2023; Chaubey & Singh, 2021; Pelacho *et al.*, 2021), which also suggested that the US was the most productive country. Notably, European and South American countries have also made significant contributions. The inclusion of Africa and Asia suggests global involvement in this field. The keyword analysis indicates that "Citizen Science" is the most prevalent keyword, highlighting the central research focus in this area. This is similar to the findings reported by other studies (Barui, 2023; Chaubey & Singh, 2021). Interestingly, we also discovered other frequently occurring keywords, including "Data Acquisition", "Data Quality", "Data Set", "Data Collection", and "Big Data", reflecting current research trends that emphasise the significance of RDM in CS. In addition, our analysis reveals that scientific subjects have more publications than non-scientific subjects, particularly in the domains of environment, technology, and biology. In contrast, non-scientific subjects tend to concentrate on social and cultural studies.

The analysis of publication years shows a steady increase in publications in RDM and CS, especially in 2021. The trend reflects growing interest and awareness of the topic, particularly over the last decade, culminating in a recent peak. Journals and conference papers stand out as the predominant publication types, as reported in other studies (Al-Lawati *et al.*, 2022; Lam *et al.*, 2022). This reflects an active engagement in empirical research and scientific discourse. Our analysis revealed an interesting pattern: the most productive author in the field of RDM in CS is Callaghan, C.T. However, his name does not appear in the top 20 most-cited articles. The author with the most citations is Goodchild, with 3,270. It suggests that Callaghan, C.T., is a highly productive author but may not be as highly cited or impactful as other authors. This is also reported in another study (Barui, 2023). Our further analysis revealed that the CNRS (Centre National de la Recherche Scientifique) was the most active institution, with the most publications among university-type institutions. This indicates that CS has gradually become a significant approach in research.

V. CONCLUSION

This study revealed a significant expansion in research on Research Data Management (RDM) in Citizen Science (CS) between 2008 and 2024, based on an analysis of 1,439 publications from the Scopus database. Key aspects identified include document types, dominant source titles, keywords, subject areas, research trends, authorship, and citation patterns. English-language journal articles, particularly in *Environmental Science*, dominate the field. *Biological Conservation* emerged as the most influential journal, with "Citizen Science" as the most frequent keyword. Europe and North America were the most active regions, and the CNRS (Centre National de la Recherche Scientifique) was the leading institution. The analysis also revealed three main thematic clusters: "RDM", "Biodiversity and Conservation", and "Data Quality Control". Callaghan, C.T., was the most productive author, while Goodchild received the highest number of citations. Co-authorship and citation analyses indicated robust collaboration networks and highlighted six highly influential authors in the field.

This study contributes significantly to the field of knowledge by offering the first comprehensive bibliometric mapping of RDM within CS, thereby deepening the theoretical understanding of how CS practices intersect with data management, particularly in areas such as data quality

and biodiversity conservation. This research trend informs the conceptual development of CS and RDM as interconnected fields. Moreover, the study highlights the dominance of scientific disciplines, underscoring the need for broader interdisciplinary integration, especially with the social sciences and humanities.

Practically, the findings provide valuable insights for stakeholders, including policymakers, funding agencies, researchers, and libraries. By identifying influential authors, institutions, and geographic contributors, the study supports strategic investment and collaboration. It also guides capacity-building efforts to strengthen data literacy and RDM practices among citizen scientists. Libraries, in particular, can leverage these insights to design targeted services and initiatives that support CS efforts in biodiversity and environmental conservation.

By bridging empirical evidence with theoretical advancement, this study offers a holistic contribution to the evolving discourse on CS and RDM. However, the analysis is limited to the Scopus database; future research could expand the scope by incorporating data from other sources, such as Web of Science or Google Scholar, to ensure broader coverage and inclusivity of relevant literature.

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