Green Technology and Environmental Sustainability in The Tourism Sector: A Bibliometric Analysis

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Abstract. Given the extensive number of empirical studies pertaining to this subject, a bibliometric study was required to create an overview of the literature on green technology and environmental sustainability. The objective of the study is to identify the most cited research journals. Six research questions were developed to study the number of publications per year, the number of citations per article, the country-wise contribution, etc. Using a bibliometric analysis, this study analyses and summarises the related literature from 1997–2023. The paper provides an all-around intellectual structure for the literature. It was found out that the research paper by Sharifi et al. (2020), entitled "The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management", published in the journal "The Science of the Total Environment," was most cited journal. China contributed the most as far as green technology and environmental sustainability are concerned. It was also found out that most of the papers were published in 2020.

Keywords: Green Technology, Sustainable Development, Citation Analysis, Tourism, Bibliometric, Visualisation Map.

1. Introduction

Green technology is a broad phrase that refers to a field of fresh, creative ways to make everyday adjustments that are more environmentally friendly. It is produced and used with consideration for the environment and natural resources. It is intended as a substitute for fossil fuels as a source of technology that causes less harm to the health of people, animals, and plants, as well as to the environment [1]. Green technology is meant to lessen the waste and pollutants that are produced during production and use. Also, it is referred to as clean technology and environmental technology [2].

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Although it can be challenging to precisely identify which fields fall under the purview of green technology, it is safe to state that " Green technology is the development and application of products, equipment, and systems used to conserve the natural environment and resources, which minimizes and reduces the adverse effects of human activities." The requirements of society should
be met by this technology in ways that won't harm or deplete natural resources in the long run [3].
Green technology can be summed up as technology that satisfies current requirements while not interfering with the ability of future generations to satiate their own needs.

Environmental sustainability indicates that natural resources should be maintained at a sustainable pace because they are often non-renewable [4]. It suggests preserving, or at the very least not destroying, environmental resources. Development may be livable, equitable, and tolerable if one of these three pillars is weak [5], but because of how these pillars interact, development as a whole is unsustainable [6].

The tourism industry must increasingly consider topics including the usage of green technologies and environmental sustainability. People are searching for more eco-friendly and sustainable forms of transportation as they become more conscious of how their actions affect the environment. By embracing renewable energy sources like solar, wind, and hydroelectric power, the tourism industry can support green technology and environmental sustainability in a variety of important ways. This can make tourism activities less carbon-intensive while also offering a more dependable and sustainable source of electricity.

The tourism sector might contribute significantly to environmental sustainability by reducing trash and improving recycling. This can involve cutting back on the use of throwaway plastics and other materials, putting in place composting and recycling initiatives, and educating visitors about their environmental impact. In the same way by collaborating with regional companies and groups, the tourism industry may also benefit regional communities and advance sustainable tourism practices. This can involve buying goods and services made locally, aiding environmental initiatives, and promoting ethical tourism practices. In terms of economic growth and job generation, tourism is one of the key industries, while Green technology and Environmental sustainability in tourism represents a global challenge. In order to review the pertinent literature, the current study will employ a bibliometric technique.

The Dimensions database is used for the bibliometric analysis of the study.It is a scholarly database that includes not just books, chapters, and conference proceedings but also grants that have been given, patents, clinical trials, policy documents, and altmetric data. It extends beyond research publications and their citations. These entities are also connected to one another in a rich multipartite extension of a citation graph. This database aims to document and provide understanding of the greater context of a piece of research [7].
The quick adoption of Dimensions by a variety of authors in the bibliometrics field is encouraging. Dimensions and other data sources have already been the subject of publications evaluating and contrasting the data quality [8][9]. At this point in the system's development, the publication index has received a lot of attention. Yet, it is evident that a more thorough examination of Dimensions linkages outside the core publications index would be beneficial to a larger audience

This paper addresses the following six research questions:
RQ1: What is the publication pattern and subject matter of the most-cited publications on green technology and environmental sustainability?
RQ2: What is the citation pattern for the most cited research papers on green technology and environmental sustainability?
RQ3: Which are the countries that contributed most between 1997-2023?
RQ4: Which organisations has the most influential publications?

RQ5: Which article has the highest number of citations and is the most popular and influential?
RQ6: What are the publication characteristics of the journals in which the most-cited research papers on green technology and environmental sustainability were published?

2. Methods and Material

2.1 Database used
The Dimension database was selected as the source for this study's search of papers pertinent to the study's subject. Some notable bibliographic databases that are frequently utilised for research evaluations include ISI Web of Science (WoS) and Google Scholar [10]. However, only the Dimension database was employed for this investigation because it has a considerably greater range of materials covered. VOS viewer is also used because it is helpful in creating networks of researchers, research institutions, countries, keywords, and concepts as well as scientific papers and journals. Co-authorship, co-occurrence, citation, bibliographic coupling, or co-citation linkages can be used to connect items in these networks.

2.2 Inclusion and Exclusion Criteria
The study comprised journal papers written in the English language that were published between the years 1997 and 2023 and that dealt with environmental science, sustainability, and green technology. Articles that did not meet the three inclusion criteria listed above were excluded.

2.3 Data extraction and cleaning
The advance search identified important documents based on the criteria. After these documents were located, a data cleaning process was run to look for missing or incorrectly recorded information.
In this method, two specific processes were used: (1) validating the data in the columns to make sure no crucial information was overlooked, and (2) cross-checking the data in the columns to make sure the field content matched the field title. Any incorrect or missing entries were erased as soon as they were found. After the final data set was verified, the list was ranked from highest to lowest based on the number of citations.
The bibliometric information of the most-cited articles was then retrieved after they had been chosen. For further analysis in this study, the list was downloaded together with the following data: a) author(s), b) author(s) ID, c) title, d) year, e) sources (journal title), f) volume, g) issue, h) times cited, I link, j) abstract and k) DOI.

3. Findings and Discussions

The findings of the above-described analyses are presented in this section. According to the ordering of the study questions, the findings are presented. Graphs, tables, and bibliometric network visualization are used to present the analyses. The results of each analysis are presented alongside a discussion of it.
*RQ1: What is the publication pattern and subject matter of the most-cited publications on green technology and environmental sustainability?*
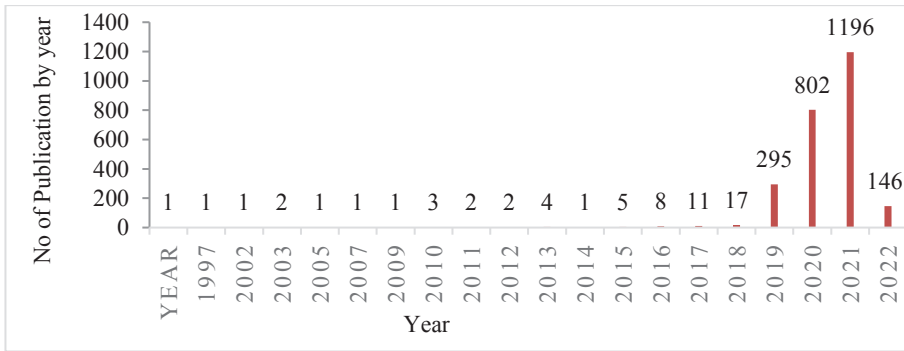
Fig. 1. No of Publications by year (1997-2022)

Figure 1 shows the total number of papers published between 1997 and 2023. As seen from figure, the number of publications on the topic was quite less until 2018, However, from 2018 onwards there is a boost in publications with an overall constant rise until 2021 when it reached the number 1196, the highest over the period. This indicates the increased interest of researchers, as well as publishers, in the topic of environmental sustainability and green technology. In 2022 the number reduced to 146 because of the after effect of Covid-19.

RQ2: What is the citation pattern for the most cited research papers on green technology and environmental sustainability?
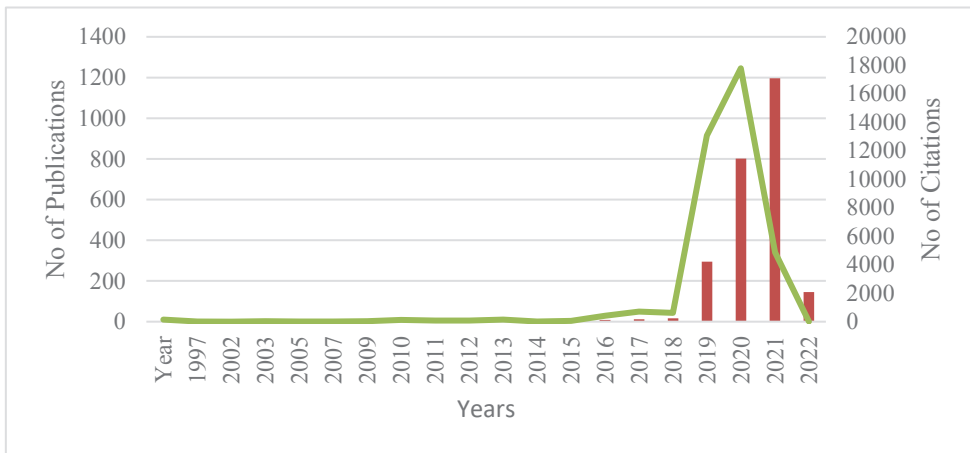
Fig. 2. No of citations per year (1997-2022)

Figure 2 shows the total number of citations for articles published between 1997 and 2023. As seen from the graph, the total of the citations dramatically increased from 2018-2020. It reached a peak in 2020. However, there was a significant decline in the years 2021 to 2022.

RQ3: Which are the countries that contributed most between 1997-2023?
Table 1 outlines the top 25 most productive countries in contributing journal articles on green technology and environmental sustainability and figure 3&4 shows the distribution of geographical publications. Of the list, the China contributed the highest number of Research

Papers (994) Followed by the Pakistan with a total of 357 articles, and United Kingdom(209). Meanwhile, France and Japan were the two countries with the lowest publications. Figure 5 shows a Visualisation map of publication network by country.

Table: 1. No of Publications per Country

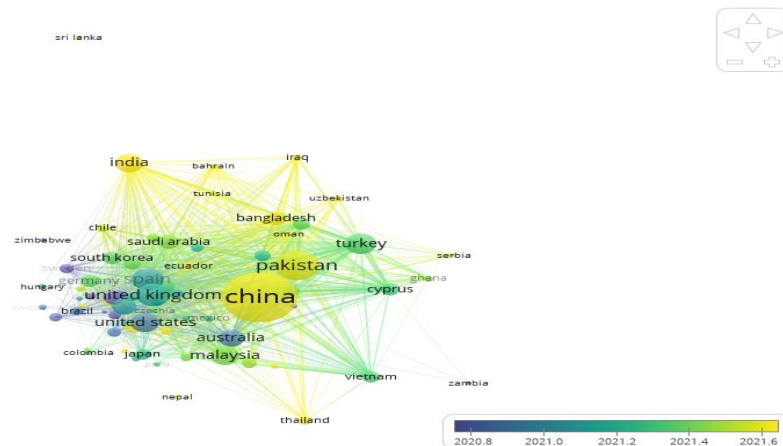| Country	No of Publications	Country	No of Publications
China	994	Cyprus	63
Pakistan	357	South korea	63
United kingdom	209	Portugal	61
Spain	188	Russia	59
Turkey	175	Vietnam	57
United states	158	South Africa	56
Malaysia	155	Taiwan	52
India	137	Iran	51
Australia	121	Nigeria	50
Italy	112	Japan	49
Bangladesh	78	France	42
Saudi Arabia	78		
Canada	77		
Germany	66		

Source: Compiled and calculated by Author
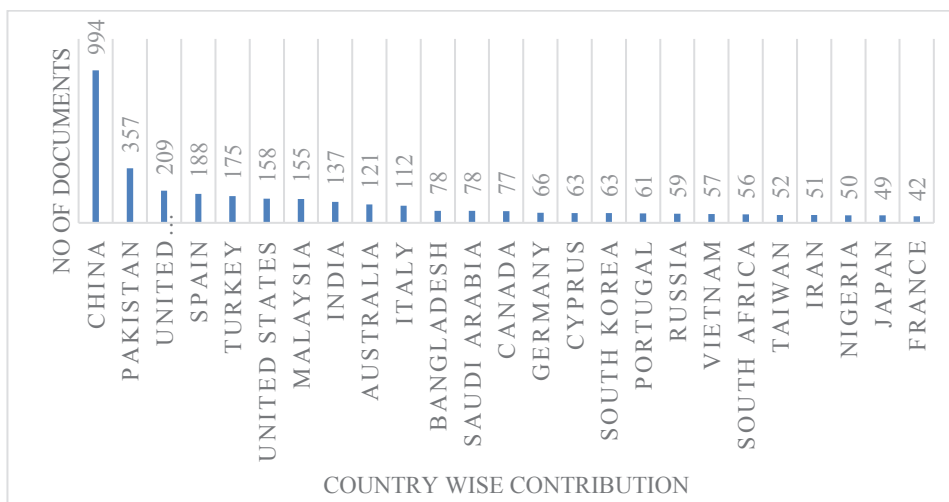
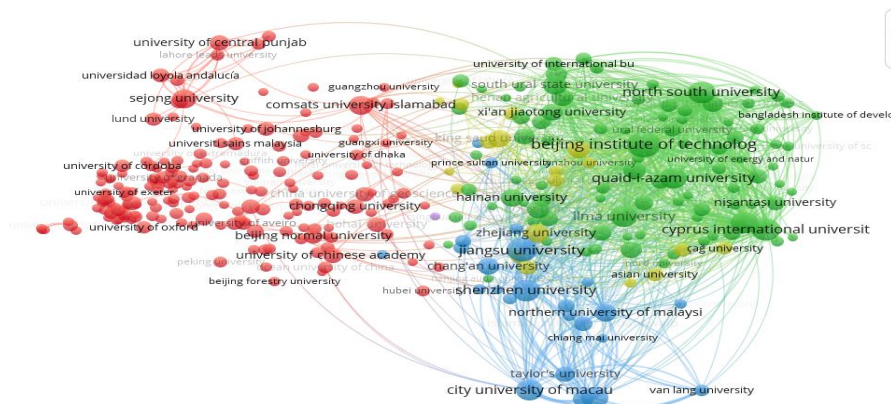**Fig. 3.** Contribution of different countries

Fig. 4. Distribution of geographical publications

Fig. 5. Visualisation map of publication network by country

RQ4: Which institution has the most influential publications?

Fig. 6. Network map visualisation of the different institution's contribution

Table 2 lists the top 20 most influential institutions with a minimum publication of 8 articles. According to the table, Beijing institute of technology, China is the institution with the highest number of published articles (53).The Cyprus international university, Cyprus was the institution with the second-highest number of published articles (38). Followed by Gelişim üniversitesi , Istanbul, Turkey (37), North south university ,Bangladesh(37), City

university of macau, China (35), Jiangsu university, China (44).The other institutions varied from 32 to 18 articles .Figure 6 shows a Visualisation map of different institution's network by country**.**

Table 2. No of citations and documents by different Institutes/Universities

Organization	Documents	Citations	Organization	Documents	Citations
Beijing institute of technology	53	1732	Taylor's university	18	859
Cyprus international university	38	1361	Zhejiang university	27	814
Gelişim üniversitesi	37	1219	Hiroshima university	10	792
North south university	37	1141	Guaid-i-azam university	34	790
City university of macau	35	1139	Iqra university	14	786
Fuzhou university	33	1078	University of technology Sydney	9	777
Jiangsu university	44	998	Islamia university of bahawalpur	16	711
Hong kong polytechnic university	17	985	Henan agricultural university	21	687
South ural state university	27	910	University of economics ho chi minh city	20	686
Northern university of Malaysia	23	869	Shenzhen university	37	679

Source: Compiled and constructed by Author

RQ5: Which article has the highest number of citations and is the most popular and influential?

The top 32 articles in performance evaluation with the most citations are included in the table 2. Over a period of 23 years, the article with the most citations was a research paper by Sharifi et al. (2020) entitled "The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management". The average annual citation count for this article was 22.65.

Table 3. Research papers with highest citations

Authors	Title	Year	Citations
Sharifi, Ayyoob; Khavarian-Garmsir, Amir Reza	The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management	2020	521
Ibn-Mohammed, T.; Mustapha, K.B.; Godsell, J.; Adamu, Z.; Babatunde, K.A.; Akintade, D.D.; Acquaye, A.; Fujii, H.; Ndiaye, M.M.; Yamoah, F.A.; Koh, S.C.L.	A critical review of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies	2020	373
Chowdhury, Priyabrata; Paul, Sanjoy Kumar; Kaisar, Shahriar; Moktadir, Md Abdul	COVID-19 pandemic related supply chain studies: A systematic review	2021	360
Hao, Fei; Xiao, Qu; Chon, Kaye	COVID-19 and China Hotel Industry: Impacts, a Disaster Management Framework, and Post-Pandemic Agenda	2020	350

Dutta, Pankaj; Choi, Tsan-Ming; Somani, Surabhi; Butala, Richa	Block chain technology in supply chain operations: Applications, challenges and research opportunities	2020	328
Mofijur, M.; Fattah, I.M. Rizwanul; Alam, Asraful; Islam, A.B.M. Saiful; Ong, Hwai Chyuan; Rahman, S.M. Ashrafur; Najafi, G.; Ahmed, S.F.; Uddin, Alhaz; Mahlia, T.M.I.	Impact of COVID-19 on the social, economic, environmental and energy domains: Lessons learnt from a global pandemic	2020	294
Belhadi, Amine; Kamble, Sachin; Jabbour, Charbel Jose Chiappetta; Gunasekaran, Angappa; Ndubisi, Nelson Oly; Venkatesh, Mani	Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries	2020	289
PatrÃcio Silva, Ana L; Prata, Joana C; Walker, Tony R; Campos, Diana; Duarte, Armando C; Soares, Amadeu M V M; BarcelÃ², DamiÃ; Rocha-Santos, Teresa	Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment	2020	278
Umar, Muhammad; Ji, Xiangfeng; Kirikkaleli, Dervis; Xu, Qinghui	COP21 Road map: Do innovation, financial development, and transportation infrastructure matter for environmental sustainability in China?	2020	252
Rume, Tanjena; Islam, S.M. Didar-Ul	Environmental effects of COVID-19 pandemic and potential strategies of sustainability	2020	252
Jiang, Peng; Fan, Yee Van; KlemeÅ¡, JiÅ™Ã JaromÃr	Impacts of COVID-19 on energy demand and consumption: Challenges, lessons and emerging opportunities	2021	249
Dogan, Eyup; Ulucak, Recep; Kocak, Emrah; Isik, Cem	The use of ecological footprint in estimating the Environmental Kuznets Curve hypothesis for BRICST by considering cross-section dependence and heterogeneity	2020	242
Pan, Shu-Yuan; Gao, Mengyao; Kim, Hyunook; Shah, Kinjal J.; Pei, Si-Lu; Chiang, Pen-Chi	Advances and challenges in sustainable tourism toward a green economy	2018	206
Lenzen, Manfred; Li, Mengyu; Malik, Arunima; Pomponi, Francesco; Sun, Ya-Yen; Wiedmann, Thomas; Faturay, Futu; Fry, Jacob; Gallego, Blanca; Geschke, Arne; GÃ³mez-Paredes, Jorge; Kanemoto, Keiichiro; Kenway, Steven; Nansai, Keisuke; Prokopenko, Mikhail; Wakiyama, Takako; Wang, Yafei; Yousefzadeh, Moslem	Global socio-economic losses and environmental gains from the Coronavirus pandemic	2020	205
Mohsin, Muhammad; Kamran, Hafiz Waqas; Atif Nawaz, Muhammad;	Assessing the impact of transition from nonrenewable to renewable energy consumption	2021	200

Sajjad Hussain, Muhammed; Dahri, Abdul Samad	on economic growth-environmental nexus from developing Asian economies		
Seddon, Nathalie; Smith, Alison; Smith, Pete; Key, Isabel; Chausson, Alexandre; Girardin, Cécile; House, Jo; Srivastava, Shilpi; Turner, Beth	Getting the message right on nature• based solutions to climate change	2021	181
Thushari, G.G.N.; Senevirathna, J.D.M.	Plastic pollution in the marine environment	2020	176
Zhang, Junyi; Hayashi, Yoshitsugu; Frank, Lawrence D	COVID-19 and transport: Findings from a world-wide expert survey	2021	173
Rosenboom, Jan-Georg; Langer, Robert; Traverso, Giovanni	Bioplastics for a circular economy	2022	159
Cheval, Sorin; Adamescu, Cristian Mihai; Georgiadis, Teodoro; Herrnegger, Mathew; Piticar, Adrian; Legates, David R.	Observed and Potential Impacts of the COVID-19 Pandemic on the Environment	2020	158
Chausson, Alexandre; Turner, Beth; Seddon, Dan; Chabaneix, Nicole; Girardin, Cécile A. J.; Kapos, Valerie; Key, Isabel; Roe, Dilys; Smith, Alison; Woroniecki, Stephen; Seddon, Nathalie	Mapping the effectiveness of nature based solutions for climate change adaptation	2020	158
Ranjbari, Meisam; Shams Esfandabadi, Zahra; Zanetti, Maria Chiara; Scagnelli, Simone Domenico; Siebers, Peer-Olaf; Aghbashlo, Mortaza; Peng, Wanxi; Quatraro, Francesco; Tabatabaei, Meisam	Three pillars of sustainability in the wake of COVID-19: A systematic review and future research agenda for sustainable development	2021	157
Martin-Rios, Carlos; Demen-Meier, Christine; Gössling, Stefan; Cornuz, Clémence	Food waste management innovations in the foodservice industry	2018	156
Helm, Dieter	The Environmental Impacts of the Coronavirus	2020	153
Wall, Geoffrey	FORUM: Is Ecotourism Sustainable?	1997	149
Khan, Syed Abdul Rehman; Yu, Zhang; Belhadi, Amine; Mardani, Abbas	Investigating the effects of renewable energy on international trade and environmental quality	2020	148
Hossain, Mokter	The effect of the Covid-19 on sharing economy activities	2020	147
Rowan, Neil J; Galanakis, Charis M	Unlocking challenges and opportunities presented by COVID-19 pandemic for cross-cutting disruption in agri-food and green deal innovations: Quo Vadis?	2020	146
Rai, Prabhat Kumar; Singh, J.S.	Invasive alien plant species: Their impact on environment, ecosystem services and human health	2020	146
Kirikkaleli, Dervis; Adebayo, Tomiwa Sunday	Do public-private partnerships in energy and renewable energy consumption matter for	2021	139

	consumption-based carbon dioxide emissions in India?	
Sun, Huaping; Pofoura, Aminatou Kemajou; Adjei Mensah, Isaac; Li, Liang; Mohsin, Muhammad	The role of environmental entrepreneurship for sustainable development: Evidence from 35 countries in Sub-Saharan Africa	2020 138
Kihombo, Shauku; Ahmed, Zahoor; Chen, Songsheng; Adebayo, Tomiwa Sunday; Kirikkaleli, Dervis	Linking financial development, economic growth, and ecological footprint: what is the role of technological innovation?	2021 136

Source: Compiled and calculated by Author

RQ6: What are the publication characteristics of the journals in which the most-cited research papers on green technology and environmental sustainability were published?
The journals with the highest number of the most-cited articles are listed in the Table 3. Only the journals with at least three articles published are listed in the table for the sake of conciseness. These journals are ordered first by total citations, then by publications per journal. The majority of the most-cited works on green technology and environmental sustainability were found in Q1-ranked journals, as can be seen from the data. There are some articles in journals with a Q2 ranking, though.

Table 4. The different Characteristics of most cited Publications

Journal name	TP	TC	CPP	CiteScore[1]	SNIP[2]	SJR[3]
Environmental science and pollution research	796	12196	15.32	6.6	1.154	0.831 Q1
The science of the total environment	110	4107	37.33	14.1	2.175	1.806 Q1
Journal of environmental management	146	3931	26.92	11.4	1.907	1.481 Q1
International journal of environmental research and public health	245	2088	8.522	4.5	1.44	0.814 Q1
Heliyon	60	824	13.73	4	1.27	0.55 Q1
Technological forecasting and social change	7	667	95.28	13.7	3.097	2.336 Q1
Journal of cleaner production	17	617	36.29	15.8	2.444	1.921 Q1
Plos one	68	590	8.67	5.6	1.368	0.852 Q1
Frontiers in psychology	126	554	4,39	4	1.605	0.873 Q1
Sustainable production and consumption	6	480	80	8.1	2.008	1.361 Q1
Resources conservation and recycling	4	477	119.3	14.5	2.943	2.589 Q1
International journal of hospitality management	7	465	66.4	12.9	2.621	2.512 Q1
Waste management	13	391	30	13.5	2.167	1.741 Q1
Global change biology	4	359	89.7	17.9	3.032	3.685 Q1

Transport policy	6	304	50.6	9	2.0 45	1.73 2 Q1
Marine pollution bulletin	21	264	12.5	9.2	1.5 17	1.50 8 Q1
Journal of air transport management	5	258	51.6	8.2	2.2 02	1.55 6 Q1
Environmental research	9	242	27.1	9.5	1.6 72	1.50 7 Q1
Environmental monitoring and assessment	24	205	8.54	4.5	0.9 96	0.62 3 Q2
Environmental management	14	202	14.4	6	1.1 79	0.84 4 Q1
Operations management research	8	185	23.1	2.8	1.2 28	0.91 7 Q1
Tourism management	8	177	22.1	19.8	3.9 86	3.38 3 Q1

Source:Compiled and Constructed by Author
TP=Total Publication; TC=Total Citation; CPP=Citation per publication; Citescore=Figures provided by Scoupus; SNIP^2 & SJR3=Figures provided by Scimagojr

The journal Environmental science and pollution research, which has the most articles as shown by the following table, is ranked Q1. On the basis of the quantity of articles, the science of the complete environment, another Q1-ranked journal, took second place. Also, it is noted that all of the aforementioned top journals are somehow associated with a variety of subject areas, including: the environment, technology, pollution, Tourism, technological forecasting, air transport etc. The broad range of these journals highlights the significance of environmentally sustainable practises and green technologies.

4. Limitations

The study's design has some shortcomings that are inherent. The absolute no of citations that each article has got was used as the search criteria to determine which papers were the most often cited. Notwithstanding the calibre and significance of the latter, this might suggest a preference for older publications over more recent ones.
The analysis relies on Dimension data, which provides detailed information about social science research. Unfortunately, we cannot confirm that our search approach has turned up all relevant journal papers because "stray citations" may have left out some crucial data. All bibliometric databases are prone to having essential data omitted [11].
Unquestionably, the data from Dimension provided a complete set of the most pertinent research that this study has produced. It should be mentioned that the data presented in this study may alter over time depending on the thematic trends that researchers take into account. Future research suggests trying several databases (like Science Direct) to obtain the bibliometric data.

5.Conclusion

Green technology and environmental sustainability are, in general, crucial factors for the tourist industry since they can help lessen the negative effects of tourism on the environment, encourage sustainable growth, and aid local communities. There are some intriguing results from this bibliometric analysis of the most-cited educational works on Green technology and

environmental sustainability. The analysis showed that authors Sharifi, Ayyoob; Khavarian-Garmsir, Amir Reza have contributed to the most publications in terms of cited educational research, while the Beijing Institute of technology, Jiangsu university, and Fuzhou university were discovered to be the top three institutions in terms of scholarly work on Green technology and environmental sustainability in tourism industry.

The findings also indicated that there is growing interest in the topic among researchers, as evidenced by the increase in publications and citations. According to the analysis, there were the most publications on the subject during the years of 2019 and 2021. The investigation also revealed that China, UK, Malaysia India and many more countries were home to the majority of this field's active authors.

Important information regarding the most well-known authors, journals, institutions, and nations has been discovered through this scientific mapping of the extensive literature on the subject of Green technology and environmental sustainability. As a result, these data offer future researchers interested in these topics, information on the major authors, crucial keywords, and the best places to focus their papers. By providing a summary of the current body of knowledge, these findings further enrich the knowledge base.

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