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HALF A CENTURY OF ENVIRONMENT PROTECTION ENGINEERING. A REVIEW

This paper provides a bibliometric and scientometric analysis of the Environment Protection Engineering (EPE) journal over the past 50 years. Using archived printed editions of EPE issues, the journal's website, and the Web of Science Core Collection, the number of publications was analyzed, including those written by foreign authors, for each year of EPE's publishing activity. The number of citations of EPE's articles each year was also assessed, and the most frequently cited works were listed. The research areas most frequently addressed in EPE articles were also identified. It was emphasized that the number of articles in the last 25 years has doubled compared to the number of articles in the first 25 years of EPE's activity. A systematic increase in the share of publications by foreign authors (relative to the total number of publications) was noted, up to 88% in recent years. Analysis of the research topics covered in the articles revealed the emergence of new aspects related to renewable energy and the circular economy.

1. INTRODUCTION

When environmental engineering, once a branch of civil engineering, first emerged in the mid-19th century, it was called sanitary engineering. Initially, the field covered water supply, water treatment, and the collection and treatment of wastewater. In the 1970s, the term sanitary engineering was replaced by the term environmental engineering. This resulted from the broadening of the field's scope to include new problems related to monitoring and reducing pollution of various environmental components (air, water, and soil). At the same time, engineers' approaches to design itself changed, and typical engineering projects began to incorporate ecological elements. Simultaneously, the concept of environmental protection, introduced in the mid-20th century as a result of public concern for the natural environment, started to undergo a transformation. The

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new term sustainable development emerged not only as a tool for environmental protection but as a long-term model for societal development.

Although the term environmental engineering has been in use for only a few decades, it addresses fundamental issues crucial to human development. Therefore, interest in sustainable development and environmental engineering has always been high and will continue to grow. Scientific journals provide a valuable forum for discussion of these topics. The Environment Protection Engineering (EPE) journal is one of the first scientific journals in Poland devoted to environmental engineering and the protection of the environment in its broadest sense. It was established 50 years ago and continues to operate today. During these fifty years, the detailed scope of the journal has undergone some modifications (Table 1). Currently, the topics of published articles focus on water and wastewater treatment, water reuse, solid waste management, air monitoring and protection, and soil monitoring and remediation. Since 2015, the EPE journal has been operating in open access.

Table 1

The scope of the EPE journal

Years	The journal profile
1975–2013	water purification; wastewater treatment; water reuse; solid waste disposal; neutralization and utilization of industrial gases; emission abatement; dedusting processes; noise and vibration control; systems of water and air pollution control; land recultivation; ecological problems; environmental economy; legislation and forecasting
2014–2020	water purification; wastewater treatment; water reuse; solid waste disposal; neutralization and utilization of industrial gases; emission abatement; dedusting processes; noise and vibration control; systems of water and air pollution control; land recultivation
After 2020	water purification; wastewater treatment; water reuse; solid waste disposal; gas emission abatement, systems of water and air pollution control; soil remediation

This article presents an overview of the EPE journal over the past 50 years. A bibliometric and scientometric analysis was conducted, taking into account the number of publications, the number of citations, the participation of foreign authors, and the leading scientific topics of the published papers.

2. ANNUAL PUBLICATION AND CITATION DISTRIBUTION OF EPE'S PAPERS

There are 1667 papers that have been released by the EPE journal between 1975 and 2024, according to search results from archived print volumes (until 2004) and journal website content (since 2005). For better clarity of the annual publication distribution, the journal's publishing activity was divided into two periods. The first period covers the years from 1975 to 2000, whereas the second period covers the years from 2001 to

2024. Figure 1 presents the information on the number of publications for the first period (Fig. 1a) and for the second period (Fig. 1b).

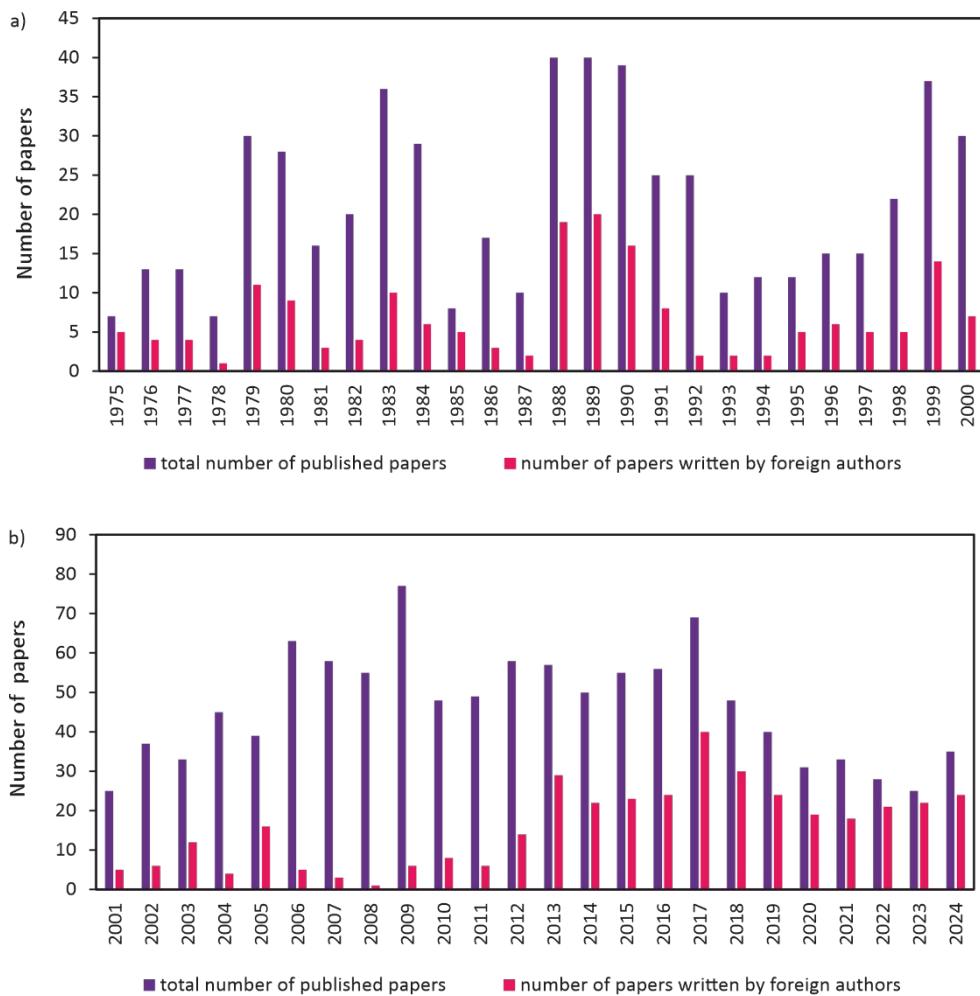


Fig. 1. Distribution of the EPE's papers by year: a) 1975–2000, b) 2001–2024

The number of papers published in the 21st century (1,114 items) was almost double that of the papers in the 20th century (553 items). This observation seems obvious, due to the development of electronic means of communication in the 21st century, which has definitively facilitated paper submission as well as editorial procedures. With the arrival of the new millennium, the scientific journal market was driven by pressure on scientists to publish their research results to improve various university rankings as well as enhance their own scientific achievements toward academic promotion.

It can be seen from Fig. 1a that there was a large number of papers published in the years 1988–1990 (about 40 papers annually). This was due to the publication of many post-conference papers. In the above-mentioned years, two prestigious international meetings were held in Poland (the ESMST Summer School Advances in Membrane Phenomena and Processes and the Sixth International Conference on Chemistry for Protection of the Environment), which were a source of valuable scientific papers written by leading Polish and foreign experts. The custom of publishing post-conference papers was abandoned at the beginning of the 21st century; thus, the two peaks with an elevated number of published papers (in 2009 and 2017) (Fig. 1b) are rather accidental, although the collective submission (for peer review) of some post-conference papers cannot be excluded. At the beginning of the new millennium, many cyclic conferences were held in Poland (e.g., Polemis, Progress in Environmental Engineering, Hydromicro).

As the EPE journal is, by definition, an international journal, the share of foreign articles in the total number of publications is also worth evaluating. The information on the annual number of foreign papers published in the years 1975–2000 and 2001–2024 is given in Figs. 1a and 1b, respectively. It can be seen that the number of foreign papers released in the 21st century (382 items) was almost twofold higher than the number of foreign papers issued in the 20th century (175 items). The reason for this observation seems very obvious – at the beginning of the new millennium, the EPE journal became more visible and accessible to international scientists through the creation of a website and the implementation of a professional editorial system (also for paper submission). The share of foreign papers in the total number of published papers has been systematically increasing since 2012. Moreover, this share became dominant, reaching 55–88% in recent years. The rather significant drop in the number of papers written by Polish authors observed in the years 2018–2024 can be attributed to the emergence of a large number of new scientific journals characterized by very short publication cycles and extremely high publication fees. It seems that the popularity of these journals among Polish authors might be related to the criteria for scientific discipline evaluation.

Generally, the papers written by foreign authors constitute around 33% of the total number of papers released by the EPE journal over the whole publishing period. Figure 2 shows the top 25 countries represented by foreign corresponding authors in the EPE journal; however, the total number of contributing countries is 58 (excluding Poland). China emerges as the primary contributor, accounting for 18.3% (102 papers) of all foreign publications. China's leading role in the dissemination of research results through intensive publication of scientific papers was confirmed by other bibliometric analyses performed in the field of environmental engineering [1–4]. Seven countries (Türkiye, Czech Republic, Iran, Italy, Slovakia, Egypt, and India) contribute to a significantly lesser degree – from 3.9 to 6.8% (in relation to all foreign papers), which equals 22–38 published articles per country. Finally, the contribution of 33 countries is individually below 1%.

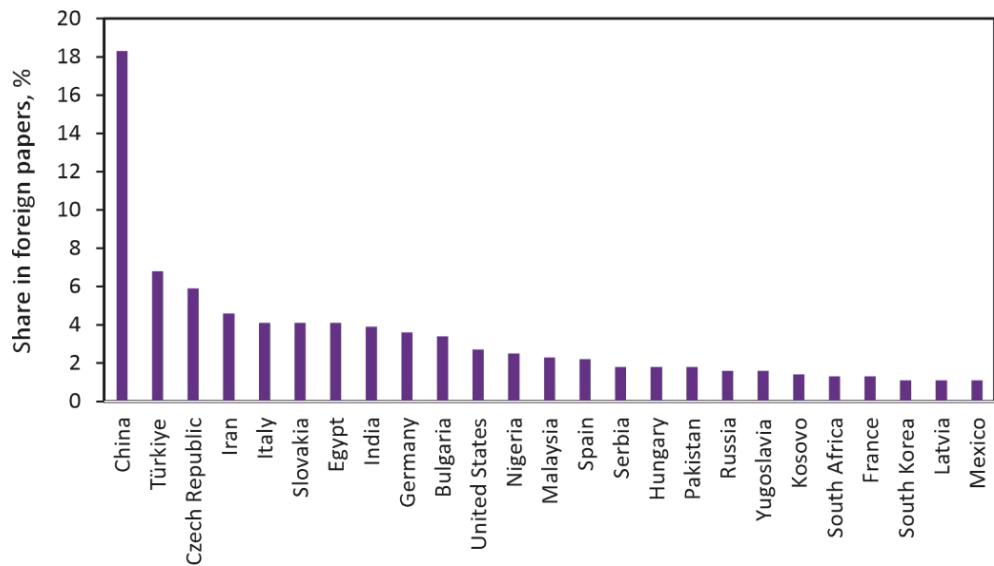


Fig. 2. The top 25 most influential foreign countries of EPE publications

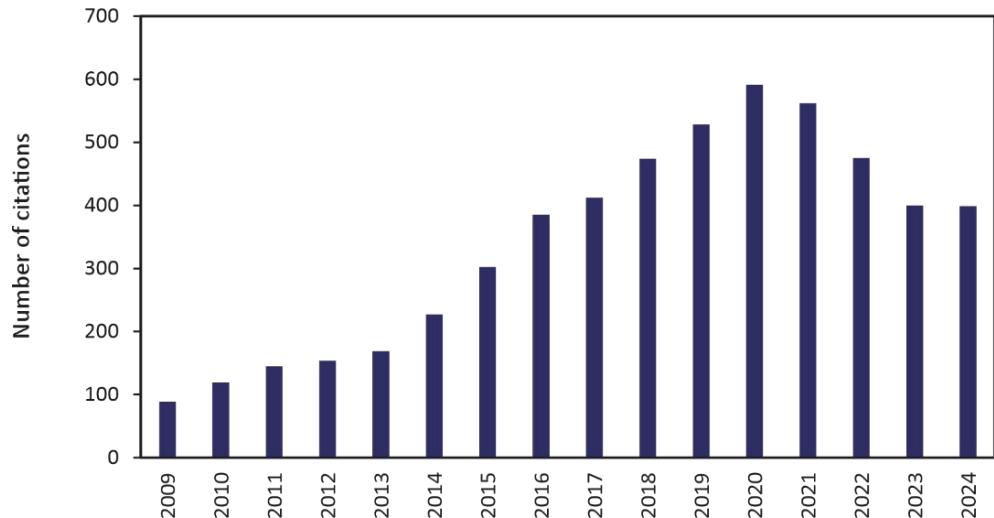


Fig. 3. Annual distribution of the EPE's papers citations (from 2009 to 2024) [5]

Table 2 presents the most cited papers published in the EPE journal (from 2007 to 2025) [5]. It is symptomatic that the most popular articles deal with general and universal environmental issues rather than specific case studies. The paper ranked first describes the physical and structural properties of clinoptilolite, which is recognized as an efficient and cost-effective adsorbent useful for the separation of various pollutants from water.

Table 2

Top 15 most cited papers published in the EPE journal between 2007 and 2025 [5]

Rank	Paper title	Author(s) (country)	Year	Total citations
1	Porosity, characterization and structural properties of natural zeolite – clinoptilolite – as a sorbent	Mansouri et al. (Iran)	2013	199
2	Energy and sustainability of operation of a wastewater treatment plant	Bodík and Kubaská (Slovakia)	2013	89
3	Photocatalytic reduction of hexavalent chromium in aqueous solutions with zinc oxide nanoparticles and hydrogen peroxide	Assadi et al. (Iran)	2012	58
4	Extraction of metals from electronic waste by bacterial leaching	Willner and Fornalczuk (Poland)	2013	55
5	Photocatalytic degradation of an organic dye in some aqueous buffer solutions using nano titanium dioxide: a kinetic study	Montazerozohori et al. (Iran)	2012	45
6	Removal of Reactive Blue 29 dye by adsorption on modified chitosan in the presence of hydrogen peroxide	Naghizadeh and Naghizadeh (Iran)	2016	40
7	An overview of municipal solid waste management in Poland. The current situation, problems, and challenges	Alwaeli (Poland)	2015	39
8	Selection of bulking agents for composting of sewage sludge	Malińska and Zabochnicka-Świątek (Poland)	2013	38
9	Effects of ZnO, CuO, Au, and TiO ₂ nanoparticles on <i>Daphnia magna</i> and early life stages of zebrafish <i>Danio rerio</i>	Liu et al. (China)	2014	36
10	Enzymatic activity in soil contaminated with the Aurora 40 WG herbicide	Baćmaga et al. (Poland)	2012	35
11	Efficiency of pollutant removal by five multistage constructed wetlands in a temperate climate	Gajewska and Obarska-Pempkowiak (Poland)	2011	32
12	Application of advanced oxidation process (H ₂ O ₂ /UV) for removal of organic materials from pharmaceutical industry effluent	Azizi et al. (Iran)	2017	31
13	Application of modified maize hull for removal of Cu(II) ions from aqueous solutions	Ghasemi et al. (Iran)	2017	31
14	Phytotoxicity and extractability of heavy metals from industrial wastes	Baran and Antonkiewicz (Poland)	2017	30
15	Sorption of Cd(II), Ni(II) and Zn(II) on natural, sodium-, and acid-modified clinoptilolite-rich tuff	Abatal et al. (Mexico)	2018	28

The second-ranked article discusses the importance of energy demand in municipal wastewater treatment plants (WWTPs). Several recommendations for improving the energy balance in WWTPs, given by the authors, are still valid, although the paper was published more than 10 years ago. In the top 15 most cited papers, there are a few papers on photocatalytic processes in pollutant removal from the environment. Some aspects

of the circular economy can be found in the paper written over a decade ago by Polish authors (*Extraction of metals from electronic waste by bacterial leaching*). Due to the intensive implementation of circular economy principles in recent years, the high number of citations (55) received by this paper is not surprising. It is worth noting that among the papers listed in Table 2, there is no paper published in recent years. Thus, at least a few years are needed to make an article visible and influential.

Table 3

Top 14 journals citing EPE by number of citations [5]

Rank	Journal name	Total citations
1	Desalination and Water Treatment	34
2	Sustainability-Basel	13
3	Energies	12
4	Journal of Water Process Engineering	11
5	Scientific Reports	10
6	Journal of Ecological Engineering	8
7	Separation and Purification Technology	8
8	Water Switzerland	8
9	Applied Science-Basel	7
10	Materials	7
11	Przemysł Chemiczny	7
12	Helyion	6
13	International Journal of Environmental Science and Technology	5
14	Journal of Environmental Chemical Engineering	5

The top 14 journals citing EPE with the highest number of citations are presented in Table 3. Although most of the citing journals are high-impact journals (e.g., Journal of Water Process Engineering with an impact factor of 6.7, Separation and Purification Journal with an impact factor of 9.2), the citation data are rather moderate, and the EPE journal should make additional efforts to increase its recognition.

3. RESEARCH TOPICS DISTRIBUTION

Detailed analysis of the paper content enabled identification of several main research clusters (Fig. 4). For both publishing activity periods, i.e., 1975–2000 and 2001–2024, the largest number of papers concerned wastewater treatment technologies (32.7% and 22.2% of all published papers, respectively). While in the first period the focus was on wastewater treatment with conventional activated sludge and the management of the resulting sludge, at the turn of the millennium, interest shifted toward more advanced and environmentally friendly technologies.

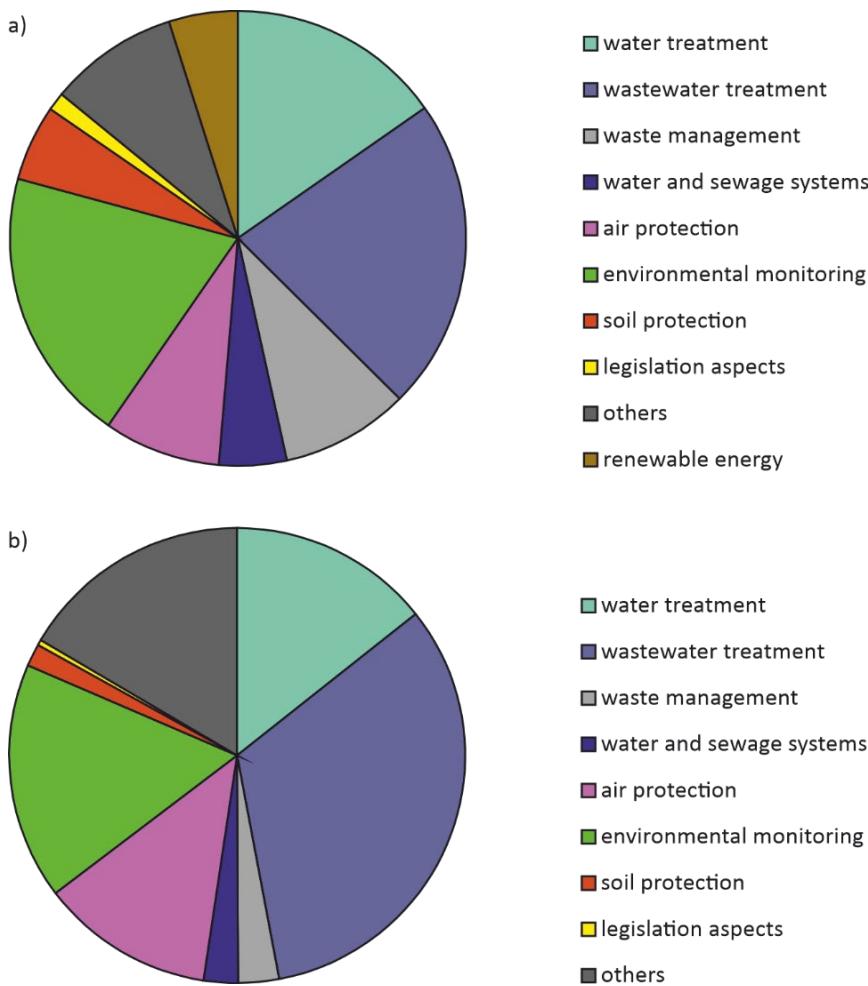


Fig. 4. Main research areas covered by EPE papers published from 1975 to 2000 (a) and from 2001 to 2024 (b)

These advanced methods included various biological reactors (sequencing batch reactors, anaerobic sludge blanket reactors, biological aerobic/anaerobic membrane reactors, biofilm reactors), a cascade system with moving bed biofilm, the DEAMOX process, adsorption by modified coal fly ash, and, more recently, the ANNAMOX process, as well as membrane processes (ultrafiltration with ceramic membranes, electrodialysis, and a biological membrane reactor integrated with nanofiltration). In the last decade of the journal's activity, a new aspect emerged, namely, water reclamation (often combined with resource recovery). The authors focused on recovering water from greywater using submerged membrane sequencing batch reactors, valorizing spent dyeing baths and laundry wastewater using membrane processes, recovering water and metals from

metallurgical wastewater, and assessing the possibility of using treated municipal wastewater for irrigation. Articles related to water reclamation and resource recovery from wastewater will likely appear with increasing frequency thanks to the implementation of circular economy principles introduced by the EU [7, 8].

The second most important research cluster is water treatment technology. Articles within this area accounted for 14.3% and 15.3% of all papers published during 1975–2000 and 2001–2024, respectively. During the first two decades of the journal's activity, the authors primarily focused on improving conventional water purification methods (coagulation, filtration, adsorption, ion exchange, infiltration), as well as mathematical modeling, mainly of filtration and adsorption. Later, articles appeared discussing the effectiveness of advanced oxidation methods for removing selected pollutants from water, the usefulness of natural materials (including clinoptilolite) in adsorption, and the use of pressure membrane techniques in drinking water purification.

Among the remaining research areas, environmental monitoring should also be highlighted. Articles in this area constitute 16.8% and 19.6% of all published works during 1975–2000 and 2001–2024, respectively. In the first period, the topics were diverse and concerned issues such as metal content in soils and bottom sediments of rivers and lakes, nutrient concentrations in aquatic ecosystems, oxygen profiles and bacteriological pollution of rivers, sulfate and sulfur content in soil, plants, and groundwater, pollution of the Baltic Sea, heavy metals in wastewater sludge, air quality around a copper smelter, sulfur dioxide concentration in air, contamination of water with PAHs, and benzo(a)pyrene (BaP) content in plants. After 2001, the share of articles related to environmental monitoring increased slightly. In addition to topics similar to those mentioned above, new research areas emerged, such as landfill leachate monitoring, soil pollution by pesticides, PM10 and PM2.5 concentrations in air, monitoring of disinfection by-products in water distribution networks, determination of endotoxins and odor in the air around wastewater treatment plants, and odor nuisance from biogas plants. The topics addressed by the authors are closely related to new EU regulations on the protection of human health (Directive EU 2020/2184 on the quality of water intended for human consumption [9], Directive EU 2024/2881 on ambient air quality and cleaner air for Europe [10]). In recent years, many articles have appeared on the use of geospatial and geovisualization methods for monitoring environmental quality, as well as on grey models, machine learning, and AI models to predict pollution of air, water, and soil.

Analysis of the diagrams in Fig. 4 shows that, in the new millennium, articles related to renewable energy have also been published, undoubtedly linked to climate policy and the promotion of renewable energy. The share of these articles in the total number of publications was approximately 5%. Furthermore, articles in the area of waste management also included issues related to the circular economy.

4. CONCLUSIONS

A comprehensive bibliometric and scientometric analysis of the Environment Protection Engineering (EPE) journal over the past 50 years was performed. During this period, around 1660 papers were published. The number of articles in the last 25 years has doubled compared to the first 25 years of EPE's activity. A systematic increase in the share of publications written by foreign authors was also noted. Of the 58 contributing countries, China was the largest contributor, accounting for 18.3% of all foreign publications. The total number of citations received by the journal in 2009–2024 amounted to 5431 (based on 891 publications). The regular increase in annual citations from 2009 to 2020 can be explained by universal Internet access and the journal's adoption of open access.

Detailed analysis of the paper content enabled identification of three main research clusters: wastewater treatment technologies, water treatment technologies, and environmental monitoring, which appeared in approximately 60% of all published articles. However, new aspects related to renewable energy and the circular economy have recently emerged. It can be assumed that interest in the EPE journal will remain high, although efforts should be made to increase the journal's visibility in international scientific databases.

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