



Mapping the Knowledge of Employee Green Behaviour and Its Research Trends Using Scopus Database : A Bibliometric Perspective

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Abstract: Sustainability has evolved as a global imperative, with Employee Green Behavior (EGB) gaining prominence as a critical concept in progressing environmental conservation within organizational settings. Employee Green Behavior reflects how individual pro-environmental actions in the workplace contribute to broader goals of sustainability. This study performs a comprehensive bibliometric analysis to map the scholarly evolution of Employee Green Behavior for the period of 2014 to 2024, with the aim of finding key publication trends, influential contributors, and emerging thematic directions. Utilizing data exclusively from the Scopus data base and employing a robust search string, the analysis reveals a consistent upward trajectory in academic output in this field of study, using advanced bibliometric tools viz., VOSviewer, Biblioshiny, and Excel, lending credibility and technical rigor to the analysis. The findings shed lights on significant contribution made by China, Malaysia, India and United Kingdom, While Noteworthy publication venues include the Journal of Cleaner Production, Corporate Social Responsibility and Environment Management, with Yusliza, Ali found to be leading prolific authors, whose work on green practices at workplace applauded across globe in this domain. The application of Exponential Growth Model (EGM) underscores the increasing academic interest and suggests the potential for further research expansion.

Keywords: Bibliometric, Employee Green Behavior (EGB), Exponential growth model, Scopus Data Base, Trends and Development.

1 Introduction:

In this current scenario of technological development and booming economies, environmental sustainability has appeared as a critical priority for organizations across globe [1]. Conversely, the worrisome increase in natural disasters has forced businesses to accelerate their efforts and adopt a gamut of initiatives to reduce their environmental impact and promote an eco-friendly workplace culture [2]. The increased consciousness has spurred a stronger social and corporate concern for environmental issues, leading to the enforcement of strict environmental legislation [3-4]. It has become necessary for them to prioritize and develop strategies that focus on green-oriented agendas viz., adoption of practices like green innovation, green production, green design, green products, and green marketing to tackle environmental challenges [5-11]. Effective pro-environmental programs depend on employees' willingness to support reforms and accept responsibility for the organization's ecological influence. [12-13]. Such willingness is often derived from the voluntary actions of the employees. An important difficulty arises when trying to convert official business sustainability strategies into the day-to- day actions of the employees [14-16]. The whole terms of this exert an impact on the sustainability-related behaviors, attitudes, awareness, and motivation of employees, prompting them to adopt more environmentally friendly activities. At this context, Employees are crucial in implementing environmental measures due to their significant impact as the human element to this phenomenon. This accomplishment of

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Environmental sustainability depends on the environmentally conscious conduct of employees, or the action incorporating the promotion of environmental protection at work- place, which is referred to as Employee green behavior (EGB) [15-16]. It also wraps employees' actions that shall have effects on the environment. It refers to the employ- ees' behaviours and actions that they take part, may either conserve or detract from environmental sustainability [17]. Studies revealed that employees prove interested in ad- dressing environmental issues when organizations clearly communicate their commitment towards conserving environment and its natural habitat [18]. So, organizations policy and strategy should support environment that emphasizes the firm's dedication to and reinforcement of its environmental policy. This, in turn, promotes and fosters innovative environmental behaviors. Mere formulation of initiative, strategies and activities is insufficient [19]. It is important to note that employees are the ones who put environmental measures into action [15]. Therefore, it is necessary to place more emphasis on creating awareness that is environmentally friendly and the human actions that is directed towards sustainability goals.

2. Significance Of the Study:

Climate change stands as one of the most pressing global challenges, posing significant threats to human development and existence, thereby needing immediate and sustained actions at various levels. This global concern has led to the incorporation of SDG 13, or climate action, into the United Nations Sustainable Development Goals, which emphasized the urgent need to mitigate climate change and its adverse effects through collective and organizational efforts [20]. In this context, employees' actions that support environmental management practices within the workplace are viewed as not only beneficial to organizations but also to the broader community [21]. The adoption of environmentally friendly behaviours by employee is recognized as vital for the effective implementation of environmental sustainability initiatives at the organizational level. Empirical studies have proved that the engagement of employees in eco-friendly practices is critical to achieving successful environmental management outcomes [22- 23], enhancing environmental performance, and giving a competitive advantage to organizations globally [24]. Moreover, Employee Green Behavior (EGB) has been widely acknowledged as pivotal for driving green initiatives within workplaces and has been identified as a key determinant in the successful execution of environmental management strategies [22-23]. Earlier studies have characterized green behaviours, both in professional and personal settings, as voluntary actions [25-26; 19] however, organizational psychologists argue that EGB may not be entirely voluntary [27]. To this end, a comprehensive classification system has been developed to conceptualize job performance in the context of EGB, forming five dimensions; supporting sustainable work practices, conserving resources, influencing others, taking initiative, and preventing harm [16]. This taxonomy recognizes that Employee Green Behaviour (EGB) encompasses both mandatory and discretionary actions, and its categories are designed to be flexible and overlapping, allowing a single behavior to be associated with multiple dimensions. The concept of Employee Green Behavior has been studied in different themes and terms viz., Green Employee Behavior [21], Workplace Green Behavior [28], Employee Environmental Behaviour, Employee Pro-environmental Behaviors [29-30] have emerged, all converging towards the common objective of promoting eco- friendly practices, reflecting the behavioural dynamics of individuals operating withing

organizational settings. Given the growing academic attention directed towards EGB, it is imperative to systematically assess and evaluate its growth and impact. This study employs bibliometric analysis, a rigorous research method that has gained momentum in academic research. Bibliometric analysis map publication history, analyse key research trends, and assess scientific output within a particular field [31-32]. The purpose of the study is to merge existing literature to provide a comprehensive understanding of EGB trends, including annual publication patterns, contributions by leading countries, influential journals, pioneering authors, and emerging keywords. Furthermore, citation analysis will be conducted to highlight the most impactful research in this domain. A critical addition to this study is the incorporation of a single country publication (SCP) and Multi-Country Publication (MCP) analysis, which will examine collaborative research efforts across different regions. Additionally, an exponential growth model will be employed to project the rapid expansion of the proposed domain for 2025-2027, capturing the accelerating trajectory of academic interest in this field. This approach enhances the relevance of the topic by offering a predictive analysis of future research trends, addressing gaps left by previous studies [33-36], and providing valuable insights for policy makers, researchers, and organizations seeking to strengthen their sustainability initiatives. By extending the existing body of knowledge, the study contributes to the growing discourse on EGB, reinforcing its role in driving sustainability and climate action.

3. Methodology and Materials: -

Bibliometric analysis is applied to understand Employee Green Behavior (EGB) and its related theme. Recently it has gained wide popularity in business research due to its associated advanced analytical supportive software viz., Gephi, Biblioshiny, Leximancer, VOSviewer, and accessible databases such as Scopus and Web of Science [37-39], reflecting its utility in managing large scientific data and achieving high research impact [40-44]. Scholars globally have contributed extensively to this field [38]. Scopus, a reliable, comprehensive, and peer-reviewed scientific database by Elsevier, is chosen for its wide coverage, indexing over 69 million entries, and acceptance in global research [39-46], making it a preferred source for accurate and dependable data analysis [38]. EGB papers retrieved from Scopus were analyzed using MS Excel, Biblioshiny [47] and VOSviewer.

3.1 Search String and Data Retrieval Process:

The data retrieval process towards this Bibliometric assessment has been conducted systematically to ensure that only the most relevant and high-quality research contributions related to Employee Green Behavior (EGB) are considered. Initially, a broad set of 3172 documents was identified through an inclusive keyword search using a combination of synonyms and related terms viz., Employee Green Behavior, Employee Green Behaviors, Green Employee Behavior, EGB, Workplace Green Behavior, Employee Environmental Behaviour, and Employee Pro-environmental Behavior, ensuring that the inclusion of diverse terminologies used in the field. To refine this large dataset and focus on contemporary research trends, the time span was limited to 2014–2024, which brought the dataset to 1501 documents, reflecting a decade-long scholarly attention. Further, to align with the core thematic area of this study, focusing on organizational

and behavioral dimensions, the search was narrowed to subject areas such as Business, Management and Accounting, and Economics, Econometrics and Finance, reducing the dataset to 310, thereby ensuring contextual relevance. To emphasize purely behavioral aspects and avoid dilution with unrelated environmental studies, documents were filtered with exact keywords about behavioral dimensions, resulting in 233 documents. Finally, to ensure academic rigor and the inclusion of only peer-reviewed, high-quality contributions, the document type was restricted to journal articles, yielding a final set of 207 articles, thereby balancing breadth and depth of research while ensuring high relevance to the study's aim.

4 Analysis and Interpretations

4.1 Main Information

Table 1 Main Information

Description	Results
OVERVIEW	
Timespan	2014:2024
Sources (Journals, Books, etc)	101
Documents	207
Annual Growth Rate %	52.72
Document Average Age	3.2
Average citations per doc	53.54
References	13662
AUTHORS	
Authors	591
Authors of single-authored docs	18
AUTHORS COLLABORATION	
Single-authored docs	22
Co-Authors per Doc	3.48
International co-authorships %	45.41
DOCUMENT TYPES	
article	207
Source: Scopus/Collation: Biblioshiny	

Employee Green Behavior (EGB) research from 2014–2024 has been increasingly important in promoting climate action, sustainability, and environmental awareness, according to a bibliometric study. The research shows an annual growth rate of 52.72% with 207 papers drawn from 101 journals and books, proving the growing interest in work-place environmental responsibility among scholars and practitioners. Aligning with worldwide sustainability movements, the document's comparatively youthful age of 3.2 years suggests that research in this subject is relatively new and constantly growing. The extensive academic background and extensive knowledge base support the Sustainable Development Goals, particularly SDG

13 on Climate Change and SDG 12 on Responsible Consumption and Production. With an average of 53.54 citations per document and 13,662 references, this material is well-supported. With 277 indexed keywords and 639 authors provided keywords, the research environment is enhanced, revealing a wide topic examination of EGB. There is a collaborative research environment clear from the 591 writers that have contributed, with 18 of them working alone. The research shows that a worldwide multidisciplinary strategy is essential for solving climate problems; there is an average of 3.48 co-authors per article and 45.41 percent of articles with international co-authorships. The preponderance of scholarly journal papers (207) provides further support for the reliability and thoroughness of the study. The increasing scholarly contribution to the proposed domain underscores its potential to drive policy frameworks, corporate sustainability strategies, and green workplace initiatives, reinforcing global climate action and fostering a sustainable business ecosystem.

4.2 Publication Trends

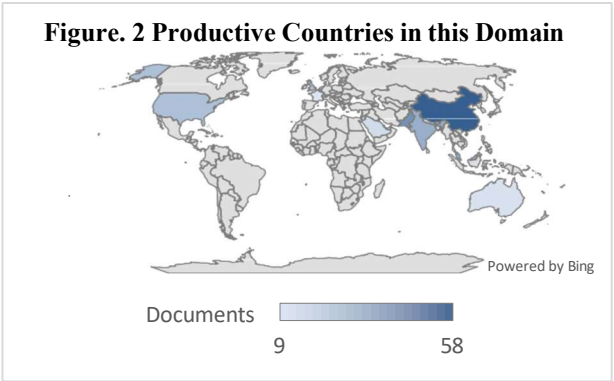


Source: Scopus Database/ Collation- MS Excel

The increasing output of research over the last decade is indicative of the growing interest in environmental concerns among both academics and professionals. In recent years, scholarly publications have increased exponentially. Starting with one publication in 2014, the number increased to six in 2015 and four in 2016, showing early scholarly research in this field. The slow increase persisted through 2017 (8 articles) and 2018 (7 articles), indicating cautious interest. After 2019, publications reached 10 and surged in 2020 (17 articles) and 2021 (16 articles). Global conversations and legislative movements toward sustainability reinforce scholarly interest in the topic. The tendency accelerated in 2022 with 27 articles, signaling a turning point in research. Scholarly interest increased dramatically in 2023 with 42 articles and peaked in 2024 with 69 articles. This high increase in research production, especially after 2020, reflects a growing recognition of the topic's relevance in organizational and policy settings. The data suggests researchers are under pressure to find solutions, evaluate repercussions, and implement sustainable methods across industries. Publications are growing exponentially, highlighting the changing academic and industrial context and the need for ongoing research and action.

4.3 Productive Countries

Analyzing research productivity across countries shows that the top ten contributing nations are dedicated to expanding knowledge in this field. Figure. 2 shed light on the top 10 countries which are most active research hubs influencing the conversation, hence their



Source: Scopus Database/ Collation- MS Excel.

contributions to literature are significant. Only countries with many publications are evaluated, resulting in a relevant research landscape assessment rather than a global overview. China leads with 58 publications, indicating its academic and policy-driven focus on research and development. With 39 publications, Pakistan has become a prominent actor, focusing on national and regional topics. Malaysia (30 publications) and India (29 publications) follow closely, highlighting Asian nations' growing influence on discourse and progressive action. European and North American nations have also contributed, with the UK (23 articles) and US (22 publications) being still major re- search centers. Their contributions prove the strong institutional support and policy frameworks that enable intellectual participation. South Korea (14 publications) and Saudi Arabia (12 publications) demonstrate the expanding scientific participation of economically advanced and strategically minded Asian and Middle Eastern states. Australia (10 publications) and France (9 publications) are industrialized economies that have led worldwide research. They show the importance of long-standing research institutions and policy actions in this field. The concentration of research in these ten nations shows that academia, industry, and policymakers are prioritizing this field. These countries' large research output shows a rising global alignment to address pertinent concerns, with each nation offering distinctive insights and solutions based on its regional aims and institutional capabilities.

Table 2 Influential Journals

<i>Journals</i>	<i>Documents</i>	<i>Country</i>
Corporate Social Responsibility and Environmental Management	22	UK
Journal of Cleaner Production	14	Netherlands
Business Strategy and the Environment	7	UK
Environment, Development and Sustainability	7	Netherlands
International Journal of Hospitality Management	7	US
Journal of Sustainable Tourism	6	UK
Social Responsibility Journal	5	UK
Cogent Business and Management	4	UK
International Journal of Manpower	4	UK
Tourism Management	4	UK

Source: *Scopus/ Collation: MS Excel*

Analysis of the most prolific journals in this field shows scholars' growing involvement with critical concerns that reflect global debate. Sustainable industrial processes are covered in 22 articles in the UK Journal of Corporate Social Responsibility and Environmental Management and 14 in the Netherlands Journal of Cleaner Production, according to Table 2. Publications in the following seven periodicals cover a wide range of topics related to corporate strategy, policy, and sustainability: International Journal of Hospitality Management (US), Environment, Development and Sustainability (Netherlands), and Business Strategy and the Environment (UK). Environmentally responsible tourism is highlighted in the 6 documents in the Journal of Sustainable Tourism (UK). The Social Responsibility Journal (UK) (5 documents), Cogent Business and Management (4 documents), International Journal of Manpower (4 documents), and Tourism Management (4 documents) show ongoing workforce and tourism sustainability efforts. UK, Netherlands, and US publications dominate critical

discussions, proving their leadership. The growing number of publications indicate research interest, strengthening their impact on organizational, economic, and environmental settings.

Table 3 Pioneer Authors

<i>Authors</i>	<i>Articles</i>	<i>Articles Fractionalized</i>	<i>Country</i>
Yusliza My	6	1.35	Malaysia
Ali M	4	0.74	Pakistan
Haque S	4	1.83	Bangladesh
Manika D	4	1.03	United Kingdom
Muhammad Z	4	0.9	Pakistan
Nisar Qa	4	0.87	Pakistan
Zacher H	4	1.08	Germany
Zhang Y	4	1.07	China
Abbas Z	3	0.53	Pakistan
Aboramadan M	3	1.58	Egypt

Source: Scopus/ **Collation:** Biblioshiny

Leading researchers in this field prove a rising dedication to academic research on environmental issues. Yusliza MY from Malaysia had the most publications, 6 with a fractionalized count of 1.35, proving Malaysia's active participation in this conversation. Ali M from Pakistan and Haque S from Bangladesh each had 4 publications, with Haque S having a fractionalized contribution of 1.83, showing a focused research effort. Manika D from the UK (4 articles, 1.03 fractionalized), Zhang Y from China (4 articles, 1.07 fractionalized), and Zacher H from Germany (4 articles, 1.08 fractionalized) prove the global nature of this research area. Pakistani researchers Abbas Z and Muhammad Z provide seven articles, boosting regional research. Despite three papers, Aboramadan M from Egypt with a high fractionalized count of 1.58, showing a research community concentration. The growing number of scholars from diverse locations shows a greater awareness and academic dedication to this field, reinforcing the interdisciplinary and international nature of sustainability-focused research.

Table 4 Citation Analysis

<i>Year</i>	<i>MeanTCperArt</i>	<i>N</i>	<i>MeanTCperYear</i>	<i>CitableYears</i>
2014	340	1	28.33	12
2015	177.5	6	16.14	11
2016	111	4	11.1	10
2017	240.25	8	26.69	9
2018	114.14	7	14.27	8
2019	102.6	10	14.66	7
2020	87.47	17	14.58	6
2021	110.25	16	22.05	5
2022	42.52	27	10.63	4

2023	18.98	42	6.33	3
2024	4.22	69	2.11	2

Source: Scopus/ **Collation:** Biblioshiny

The citation analysis in table-4 presents a crucial measure of the impact and recognition of research contributions over time. 2014 had the greatest mean citations per article (MeanTCperArt) of 340, showing a significant contribution despite only one paper being published. In 2024, there were 69 published articles (N), showing a rise in research. As newer publications take longer to gain citations, the typical citation count per item dropped to 4.22 in 2024. A high in 2017 was seen in eight articles with MeanTCperArt of 240.25 and MeanTCperYear of 26.69, showing continuous scholarly activity. However, 2015 and 2016 had moderate citation changes with MeanTCperArt of 177.5 and 111. The rise of citable years from 12 in 2014 to 2 in 2024 shows how research visibility is changing. Earlier investigations had a lasting impact, while later articles are still obtaining scholarly acceptance. From 28.33 in 2014 to 2.11 in 2024, MeanTCperYear has declined due to the natural citation lag for newer research, not relevance. The continual increase in research production highlights academic concentration on this topic, adding to a wider body of literature that will affect worldwide research and policy frameworks.

Table 5. Research Collaboration Patterns: Single-Country vs. Multi-Country Publications (SCP/MCP) Analysis

Country	Articles	Articles %	SCP	MCP	MCP %
China	47	22.70531	25	22	46.81
India	21	10.14493	20	1	4.76
Pakistan	18	8.695652	11	7	38.89
Malaysia	14	6.763285	6	8	57.14
United Kingdom	10	4.830918	4	6	60.00
Korea	7	3.381643	2	5	71.43
Czech Republic	5	2.415459	2	3	60.00
Saudi Arabia	5	2.415459	2	3	60.00
Usa	5	2.415459	0	5	100.00
Turkey	4	1.932367	3	1	25.00
Australia	3	1.449275	1	2	66.67
France	3	1.449275	0	3	100.00
Germany	3	1.449275	2	1	33.33
Hong Kong	3	1.449275	1	2	66.67
Hungary	3	1.449275	0	3	100.00
Indonesia	3	1.449275	2	1	33.33
Iran	3	1.449275	1	2	66.67
United Arab Emirates	3	1.449275	0	3	100.00
Afghanistan	2	0.966184	0	2	100.00
Bangladesh	2	0.966184	1	1	50.00
Greece	2	0.966184	2	0	0.00
Italy	2	0.966184	2	0	0.00
Nigeria	2	0.966184	1	1	50.00

Norway	2	0.966184	1	1	50.00
Poland	2	0.966184	1	1	50.00
South Africa	2	0.966184	2	0	0.00
Spain	2	0.966184	2	0	0.00
Brazil	1	0.483092	1	0	0.00
Canada	1	0.483092	0	1	100.00
Cyprus	1	0.483092	0	1	100.00
Iraq	1	0.483092	0	1	100.00
Macedonia	1	0.483092	0	1	100.00
New Zealand	1	0.483092	0	1	100.00
Qatar	1	0.483092	1	0	0.00
Sri Lanka	1	0.483092	0	1	100.00
Thailand	1	0.483092	1	0	0.00
Vietnam	1	0.483092	1	0	0.00

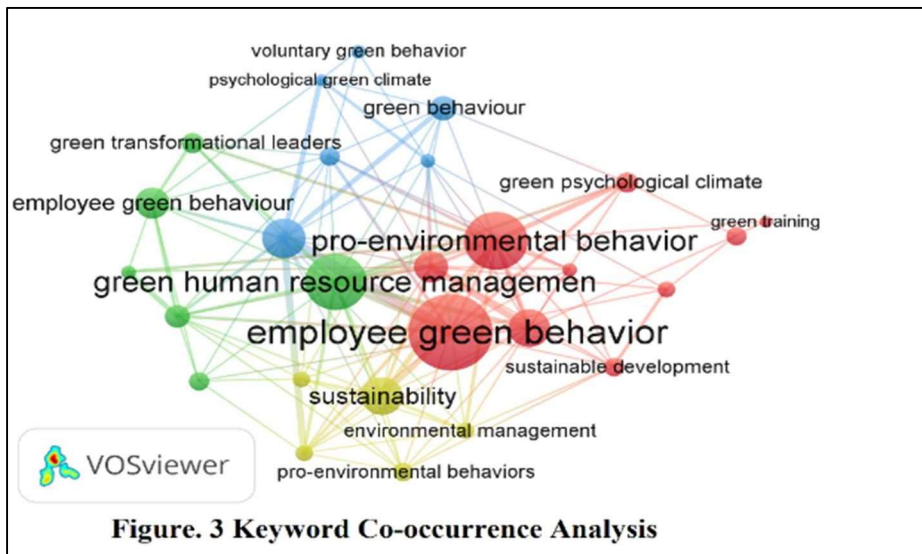
Source: *Scopus/ Collation: Biblioshiny*

Understanding research collaboration patterns is crucial in assessing the global interconnectedness of scientific advancements and the extent of knowledge exchange across borders. A comparison of SCPs and MCPs, as shown in table 5, sheds insight into the level of international collaboration among researchers, which in turn reflects the worldwide effort to solve critical problems. SCP and MCP rank second and third with 25 and 22 publications, respectively, while China leads with 22.71% of papers. Indian dependence on SCP (95.24%), which contributes for 10.14% of its contribution, limits global collaboration. Pakistan (8.7%) collaborates more (38.89% MCP), although Malaysia (57.14% MCP) and the UK (60% MCP) emphasize international research. USA, France, UAE, and Afghanistan have 100% MCP worldwide cooperation, whereas Korea (71.43%) and Australia (66.67%) have significant global networking. Turkey (25% MCP) and Indonesia (33.33% MCP) are more localized. Canada, Cyprus, Iraq, and Sri Lanka are completely reliant on international research collaboration. The growing MCP trend suggests greater global cooperation in addressing sustainability concerns, which aligns with SDG aspirations. While some countries have distinct research cultures, those with high MCP percentages contribute significantly to global scientific debate. Expanding cooperation in low-MCP countries may improve research impact and information exchange. The data highlights the need of cross-border collaboration in addressing sustainability concerns efficiently.

4.4 Keyword Co-occurrence Analysis

Significant developments in Sustainability and Ecological responsibility have been uncovered via the co-occurrence analysis of author keywords, which considers at least five occurrences, as shown in figure 3. The co-occurrence analysis of 34 terms from 639 finds important research trends in sustainability and environmental responsibility. Employee green behavior takes the lead with 36 occurrences and 29 link strength, showing the workplace’s environmental commitment. Pro-environmental behavior (27 occurrences, 32 link strength) and green HRM (18 occurrences, 30 link strength) both underline the importance of sustainability in HR practices. Business social responsibility (CSR) (17 occurrences, 23 link strength) and sustainability (17 occurrences, 20 link strength) both demonstrate business commitment. Environmental knowledge (10

occurrences, 17 link strength) and environmental performance (7 occurrences, 15 link strength) connect awareness and action. Green psychological climate (9 occurrences, 10 link strength), green self-efficacy (8 occurrences, 13 link strength), and green trans



Source: Scopus Database/ **Collation-** MS Excel.

Formational leadership (9 occurrences, 8 link strength) all demonstrate psychological and leadership aspects. The report highlights the rising integration of sustainability into business policies, workplace culture, and employee-driven initiatives, which align with global sustainability goals.

4.5 Exponential Growth Model

Expansive networks, citation patterns, and research trends are all predicted under the exponential growth model. Research in fields like sustainability, renewable energy, and health relies heavily on it [48-52]. The following formula may be used to forecast future publications using linear regression:

$$P(t) = a \cdot e^{b(t-2014)}$$

where:

- $P(t)$ is the number of publications in year t .
- $a=1.18$ (first scale factor).
- $b=0.4031$ (growth rate parameter).
- e is Euler's number (~ 2.718).

Annual Growth Rate Calculation:

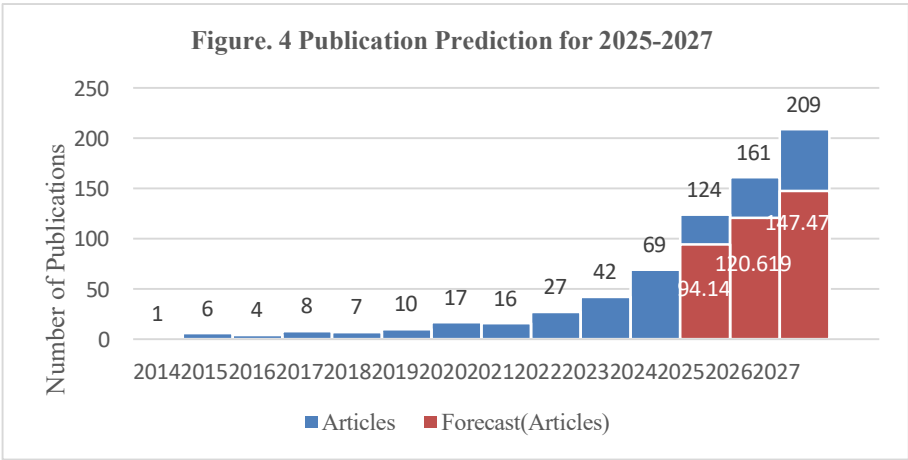
$$r = (e^b - 1) \times 100$$

- Substituting $b=0.4031$:
- $r = (e^{0.4031} - 1) \times 100 = 49.64\%$

Future Predictions:

Using the equation above:

- **2025:** $P(2025) = 1.18 \times e^{0.4031 \times (2025-2014)} = 94.19 \approx 94$
- **2026:** $P(2026) = 120.619 \approx 121$
- **2027:** $P(2027) = 147.473 \approx 147$



Source: Authors Calculation based on Exponential Growth Model.

The EGM predicts a significant increase in research publications from 2025 to 2027, with estimates of 94 in 2025, 121 in 2026, and 147 in 2027, indicating an accelerated research trajectory. This trend reflects a long-term increase in scholarly contributions, owing to increased academic interest, advances in research methods, and institutional support. The model emphasizes the growing research environment, representing the dynamic evolution of information transmission in crucial disciplines such as sustainability, renewable energy, and health sciences. The continued increase in publications proves the expanding importance of these subjects, needing careful academic planning and resource allocation. Such exponential development not only underlines the need of ongoing re- search but also is a larger intellectual movement that will shape future scientific debate.

5. Implications of the study

The implications of this study are multifaceted, reflecting both theoretical advancements and practical significance. The exponential growth in research publications under- scores an increasing scholarly focus, reinforcing the evolving discourse in sustainability, renewable energy, and health sciences. This trajectory signifies a change in basic assumptions in academic inquiry, needing enhanced interdisciplinary collaboration, methodological refinements, and policy integration. The findings offer critical insights for academia, funding agencies, and policymakers, emphasizing the need for sustained investment in research infrastructure and knowledge dissemination. Moreover, the upward trend highlights the necessity for adaptive institutional strategies to accommodate expanding research outputs, fostering innovation and evidence-based decision-making. This study contributes to shaping future academic and industrial landscapes, reinforcing the imperative of knowledge-driven advancements in addressing global challenges.

6. Conclusion

The paper presents a thorough examination of the exponential growth in research publications, emphasizing the growing scholarly focus on crucial fields such as sustainability, renewable energy, and health sciences. The projected trends imply that academic contributions will continue to expand, emphasizing the importance of improved research infrastructure, multidisciplinary collaboration, and policy-driven support. The results highlight the growing importance of information transmission in creating future academic and industrial landscapes. Finally, this study emphasizes the critical role of research in tackling global concerns, pushing for long-term innovation and evidence-based decision-making to achieve significant progress.

7. Limitations & Future Scope:

The study's potential limitations include reliance on historical publication trends, which may not fully capture future disruptions or shifts in research priorities. The exponential growth model assumes a continuous growth rate while ignoring external factors such as financing limits, legislative changes, or technical improvements that could alter publication trends. Variations in data quality, accessibility to publications, and regional research discrepancies may also have an impact on projection accuracy. Despite these limitations, the study gives useful insights into new research pathways; however, future studies should include adaptive models, qualitative assessments and explore sectorial level analysis to provide a more complete understanding.

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