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Analysis of Global Research Trends in Psychological Approaches and Behavioural Change to Waste Management

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ABSTRACT

The integration of psychological perspectives into waste management research has gained significant momentum in recent decades, reflecting a growing emphasis on behaviour-driven solutions to environmental challenges. This bibliometric analysis aims to systematically map the scientific landscape at the intersection of psychological interventions and waste management from 1992 to 2024, highlighting trends, thematic evolution, and collaboration patterns. A total of 1927 records were retrieved from the Scopus and Web of Science databases and analysed using the Bibliometrix R-package. The study explores annual publication trends, core journal sources, influential authors, country-wise scientific production, and conceptual structures through keyword co-occurrence, factorial mapping, and thematic analysis. Findings reveal a steady increase in annual scientific production, with exponential growth post-2010 and a record peak in 2024, indicating rising academic and policy interest in pro-environmental behaviour. Core journals such as Sustainability, Journal of Cleaner Production, and Waste Management dominate the publication landscape, while geographic trends highlight China, the United Kingdom, and the United States as major contributors. Thematic evolution shows a transition from technical and region-specific issues to behaviourally informed, people-centered approaches, including constructs such as pro-environmental behavior, circular economy, and community engagement. Factorial analysis via MCA demonstrates a conceptual divide between theory-driven research (e.g., Theory of Planned Behavior, norms, policy) and empirically focused studies (e.g., surveys, behavior change, demographics), with central constructs like sustainability and attitude bridging these themes. This study consolidates the intellectual development of this interdisciplinary domain and offers strategic insights for future research in sustainable behaviour, environmental psychology, and global waste governance.

Keywords: *Behavioural Change, Psychological Approaches, Waste Management, Research Trends, Bibliometric Analysis*

1. INTRODUCTION

Over 2.24 billion tonnes of municipal solid waste are generated globally each year, and this is expected to rise to 3.88 billion tonnes by 2050, placing unprecedented pressure on environmental systems and public health [1]. In this context of escalating urbanization and consumerism, solid waste management (SWM) has emerged as one of the most critical environmental challenges of the 21st century [2]. Solid waste management affects every single person in the world, whether individuals are managing their own waste or governments are providing waste management services to their citizens.

As nations and cities urbanize, develop economically, and grow in terms of population, the World Bank estimates that waste generation will increase from 2.01 billion tonnes in 2016 to 3.40 billion tonnes in 2050. At least 33% of this waste is mismanaged globally today through open dumping or burning [1]. While technological and infrastructural advancements have contributed to improving waste systems, the effectiveness of sustainable waste practices still hinges largely on

human behaviour. Issues such as improper waste segregation, littering, and overconsumption are rooted in behavioural patterns that influence both the quantity and quality of waste generated [3], [4].

To address this behavioural dimension, researchers and policymakers have increasingly turned to psychological interventions such as nudges, behavioural cues, attitude change models, and community-based social marketing to reshape individual and group waste-related habits. These strategies are often informed by well-established theories like the Theory of Planned Behaviour [5] and Social Cognitive Theory [6], which emphasize the role of motivation, social norms, and perceived control in shaping pro-environmental behaviour. These interventions aim to make sustainable waste practices not only accessible but also socially and psychologically rewarding.

The psychological determinants of waste management are multifaceted, influenced by various socio-cultural, cognitive, and behavioural factors. Research has consistently shown that psychological stress among waste management workers can significantly affect their performance and overall well-being. Research highlight that the nature of waste management jobs often leads to increased psychological stress, particularly due to exposure to hazardous materials, which can be more stressful than similar physical tasks in other sectors [7]. Factors like normative behaviours and social norms strongly influence how individuals engage with waste management practices. Tian and Zheng emphasize that cultural customs and collective societal attitudes significantly affect food waste generation, noting that individuals often conform to social norms regarding waste [8].

One of the foundational theories employed in understanding waste management behaviour is the Theory of Planned Behaviour (TPB), which incorporates elements such as attitudes, subjective norms, and perceived behavioural control [9]. For example, a study focusing on Chinese household kitchen waste separation identified five psychological factors: attitude, perceived behavioural control, subjective norms, moral norms, and responsibility denial, which significantly predict waste sorting behaviours [10].

The integration of psychological theories into waste management interventions also suggests employing a multi-faceted approach that includes strategies responsive to individuals' emotional and social contexts. Community-based practices that utilize local norms and values have been shown to significantly enhance recycling participation across different settings [11], [12]. Establishing a sense of community ownership regarding waste management initiatives can foster collective action, further promoting sustainable practices.

Bibliometric analysis is a quantitative method used to evaluate the scientific structure, growth trends, and intellectual landscape of a research domain through the examination of publications, authorship patterns, keywords, and citations [13]. For this study, a bibliometric approach was applied to map the evolution and knowledge structure of literature related to psychological interventions in solid waste management specifically focusing on pro-environmental behaviour change.

Bibliometric methods provide quantitative and visual insights into research trends, influential theories, core authors, collaboration networks, and thematic hotspots [14]. By identifying these patterns, this study not only addresses a critical gap in both environmental and psychological research but also lays the foundation for future cross-disciplinary collaboration and intervention design.

Need and Significance of the Study

The global increase in solid waste generation, driven by rapid urbanization, economic growth, and changing consumption patterns, has created significant environmental and public health challenges. Although technological innovations and infrastructure development have enhanced waste collection and processing systems, the success of Solid Waste Management (SWM) still largely depends on the behaviour of individuals and communities. Recognizing this, researchers have increasingly explored psychological interventions including nudges, behaviour change models, attitude-focused campaigns, and community-based strategies to encourage pro-environmental behaviour in the context of waste management. However, the existing body of literature is scattered across disciplines and lacks a systematic, data-driven synthesis of how psychological theories and tools have been applied to SWM practices. A bibliometric analysis is therefore warranted to fill this gap. By quantitatively mapping publication trends, influential authors, dominant themes, and theoretical foundations, this study offers a comprehensive overview of the intellectual landscape of psychological interventions in SWM.

Objectives

1. To examine the growth trends and publication patterns
2. To identify the most influential authors, journals, and institutions
3. To analyse the theoretical foundations and psychological models
4. To highlight gaps and emerging areas in the literature for future interdisciplinary research

2. METHODS

This study employed a bibliometric analysis to explore global research trends on psychological interventions for behaviour change in Solid Waste Management. Bibliometric analysis is a quantitative research method used to evaluate the structure, impact, and trends within a scientific domain through statistical and network-based approaches [15]. A total of 1,927 documents were retrieved from the Scopus and Web of Science databases, covering the period from 1992 to 2024 (Fig.1). The collected data were analysed using Bibliometric (R package). This approach enabled the identification of leading contributors, influential theories, thematic clusters, and research gaps, offering a comprehensive overview of the intectual landscape in this interdisciplinary domain.

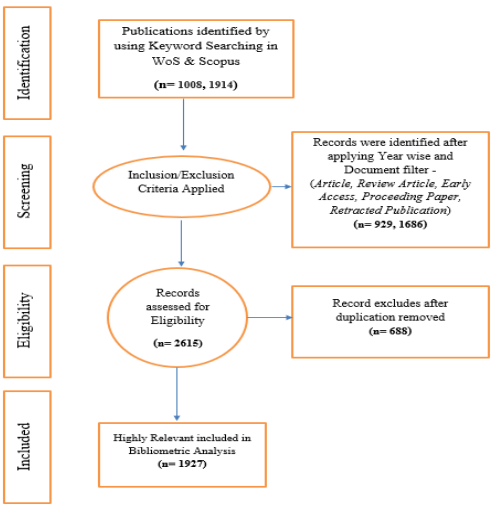

Figure 1. Methodology Flow Chart

The data collection stage involves extracting relevant research articles from selected databases using well-defined search queries. The search query has been used for extracting documents from Web of Science (WOS) and Scopus are listed below;

WOS;

TS= (("psychological intervention" OR "psychological determinant*" OR "environmental psychology" OR "behaviour change" OR "theory of planned behavior" OR "value belief norm" OR "nudg*" OR "pro-environmental behaviour") AND ("waste management" OR "solid waste" OR "municipal waste" OR "household waste" OR "waste segregation" OR "waste sorting" OR "source separation" OR "recycling" OR "composting" OR "waste disposal"))*

SCOPUS;

TITLE-ABS-KEY(("psychological intervention" OR "psychological determinant*" OR "environmental psychology" OR "behaviour change" OR "theory of planned behavior" OR "value belief norm" OR "nudg*" OR "pro-environmental behaviour") AND ("waste management" OR "solid waste" OR "municipal waste" OR "household waste" OR "waste segregation" OR "waste sorting" OR "source separation" OR "recycling" OR "composting" OR "waste disposal"))*

2.1 Data Analysis

The analysis was conducted using specialized bibliometric tools, Biblioshiny (an R-based bibliometric package) (Aria and Cuccurullo, 2017). The following techniques were applied:

1. Descriptive Analysis: This involved the identification of publication trends, prominent journals, influential authors, and citation metrics.
2. Co-occurrence Analysis: Keywords were analysed to visualize the thematic structure of the research field using network maps.
3. Thematic Mapping: Themes were classified based on relevance and development degree using a two-dimensional analysis, categorizing topics into Basic Themes, Motor Themes, Niche Themes, and Emerging or Declining Themes.
4. Collaboration Network Analysis: Country-level collaboration networks were assessed to identify leading research hubs and international partnerships.

Thematic Evolution Analysis: Temporal changes in research focus were mapped using Sankey diagrams to trace the progression of topics over different time periods.

3. RESULTS AND DISCUSSION

3.1 Annual Scientific Production

The temporal distribution of publications reveals a *clear upward trajectory* in the scholarly attention given to the *psychological dimensions of waste management*. From a modest output of just *1 to 7 articles annually* during the early 1990s, the field has witnessed a *consistent and robust expansion* over the decades (Fig.2).

Between *1992 and 2005*, annual publications remained *relatively low*, fluctuating between *1 and 11 articles per year*. This phase can be interpreted as the *nascent stage of research*, where the integration of *psychological concepts* such as *behavioural change*, *environmental attitudes*, and *psychological interventions* into waste management was still emerging. A *gradual increase* began post-2006, with publications rising to *15 in 2007* and then *steadily increasing* each year. This suggests a growing recognition of *behavioural and psychological factors* in influencing *sustainable waste practices*.

A *significant surge* occurred from *2011 onwards*, with the number of publications increasing from *36 in 2011* to *138 by 2019*. The *most dramatic growth* is observed from *2020 onwards*, likely spurred by *global sustainability initiatives* and *heightened awareness during the COVID-19 pandemic*. In *2020*, *170 articles* were published, which rose to *223 in 2021*, *233 in 2022*, and *247 in 2023*. The year *2024* stands out as the *most prolific year to date*, with a record *291 publications*. This *exponential rise* underscores the

growing importance of understanding *human psychology*, *behavioural interventions*, and *community participation* in driving *effective waste management strategies*.

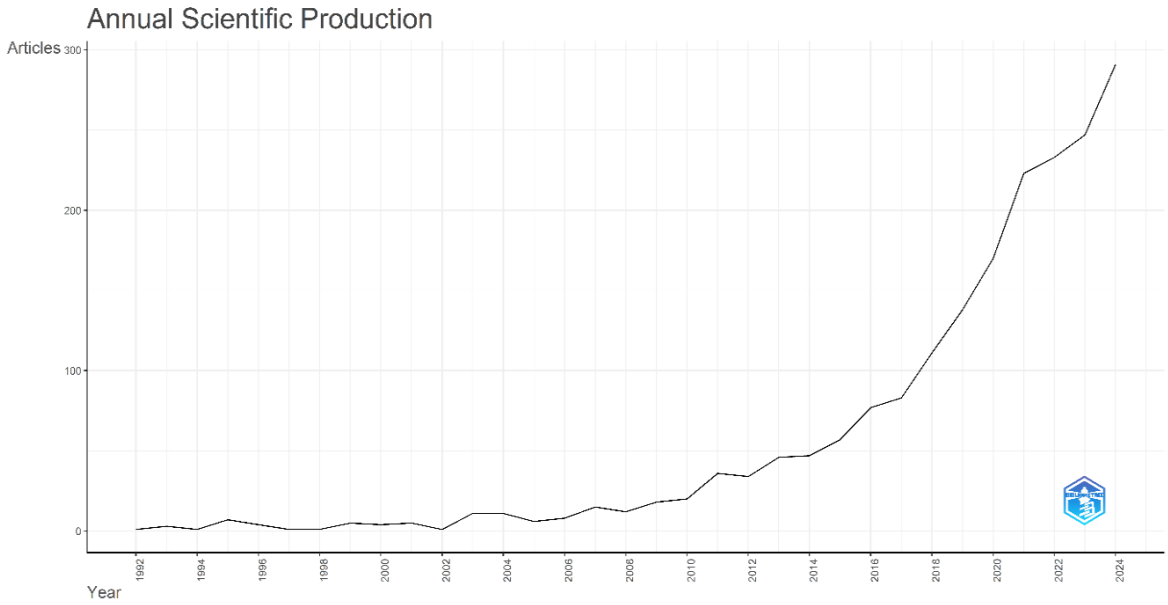

Figure 2. Annual scientific production (all figures in this paper, except Fig.7 and Tab. 1 has been prepared using biblioshiny [14]).

3.2 Average Citations Per Year

The analysis of average citations per year reveals that *early publications (1992–2005)* had a *disproportionately high impact* despite limited output. Years like *1995* (*248.00 citations per article*), *1998* (*221.00*), and *1999* (*512.40*) reflect the influence of foundational studies that shaped the field's direction. A similar trend continued in the *mid-2000s*, with notable peaks in *2007* (*212.20*) and *2015* (*269.02*), highlighting the rising relevance of psychological frameworks in waste-related research. However, from *2016 onward*, a clear *decline in average citations* is observed, with figures dropping to *40.34* in *2020*, *17.24* in *2022*, and just *3.77* by *2024*. This downward trend is largely a result of the *recency effect*, as newer publications have had less time to accrue citations, combined with the *rapid expansion of publication volume* in recent years. Despite the decline, the data underscores a *maturing research landscape*, where the emphasis has shifted from a few seminal works to a broader and more diverse body of literature.

3.3 Most Relevant Sources

The distribution of articles across journals highlights *Sustainability* as the leading publication outlet, with *114 articles* contributing to the discourse on psychological aspects of waste management. It is closely followed by the *Journal of Cleaner Production* and *Waste Management*, which published *87* and *85 articles* respectively, underscoring their central role in this interdisciplinary field. Other significant journals include *Resources, Conservation and Recycling* (notably appearing twice with *68* and *41 articles*, possibly indicating data overlap), the *International Journal of Environmental Research and Public Health* with *66 articles*, and the *Journal of Environmental Management* contributing *43 articles*. Specialized outlets such as the *Journal of Environmental Psychology* and *Environment and Behavior* also play important roles, with *33* and *22 articles* respectively, reflecting the integration of psychological theories in environmental research. This journal landscape illustrates the broad academic interest spanning environmental science, public health, and behavioral studies, reinforcing the multidisciplinary nature of research on psychological determinants in waste management.

3.4 Core Sources by Bradford's Law

Bradford's Law, introduced by [16], describes the dispersion of articles across scientific journals. The plot based on this Law which visualizes the distribution of articles across various journals, identifying the core sources that publish the highest volume of research in the analysed domain. In this context, Bradford's Law helps pinpoint the most prolific journals, which serve as central platforms for scholarly communication in environmental behavior and waste management research.

At the top of the list is the journal Sustainability, which clearly dominates the field in terms of publication volume, suggesting its critical role in disseminating research related to sustainable practices, behavior change, and environmental policy (Fig.3). This is followed by Journal of Cleaner Production and Waste Management, both of which are highly respected and widely cited journals focusing on applied environmental research and practical solutions to waste challenges. Resources, Conservation and Recycling also features prominently, reinforcing its status as a key outlet for studies on resource efficiency and circular economy practices.

Other significant core journals include the International Journal of Environmental Research and Public Health, Journal of Environmental Management, and Sustainable Cities and Society, each contributing substantially to cross-disciplinary discussions on environmental systems, public health, and urban sustainability. The appearance of Environment, Development and Sustainability and Frontiers in Psychology highlights the growing integration of psychological and behavioral science perspectives in environmental research.

The shaded "core sources" zone in the plot encapsulates those journals that collectively publish a disproportionately high number of articles relative to others, making them indispensable for researchers aiming to stay updated, conduct literature reviews, or identify suitable venues for publication. This concentration also underscores the thematic convergence of sustainability, behavioral science, and environmental systems within these high-impact journals.

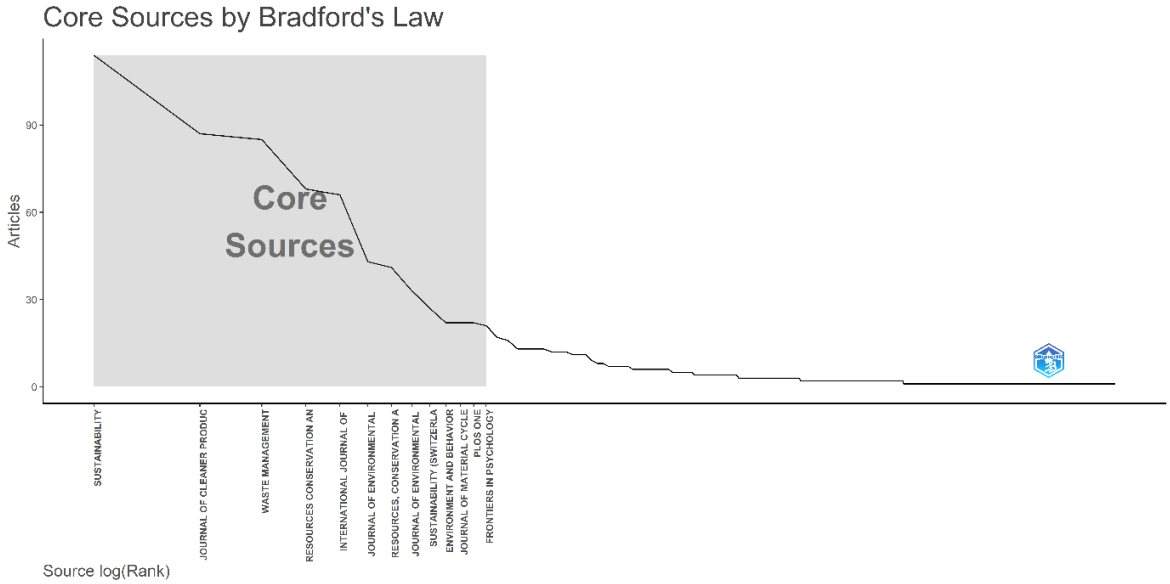

Figure 3. Core Sources by Bradford's Law

3.5 Sources' Local Impact

The analysis of journal impact reveals that the *Journal of Cleaner Production* leads with the highest *h-index of 45* and a total citation count of *6253* across *87 articles* since its involvement began in *2007*. Close contenders include *Resources Conservation and Recycling*, boasting an *h-index of 41* and *6809 total citations* from *68 publications* starting in *2003*. Despite publishing fewer articles (*33*), the *Journal of Environmental Psychology* stands out with the highest total citations of *7748* and an *h-index*

of 25, reflecting its critical role in shaping psychological perspectives within waste management research. *Waste Management* also demonstrates strong influence, with an *h-index of 40* and *5740 citations* over *85 articles* since *2009*. Other notable journals include *Sustainability* (h-index 27, 2346 citations, 114 articles), *Journal of Environmental Management* (h-index 25, 3315 citations, 43 articles), and *Environment and Behavior* (h-index 19, 3941 citations, 22 articles), each contributing uniquely across varying timelines. More recent entrants like *Frontiers in Psychology* (h-index 13, 578 citations, 21 articles) indicate expanding interest in psychological frameworks. Overall, these metrics emphasize a diverse but concentrated set of journals that anchor the evolving research landscape on psychological determinants of waste management.

3.6 Most Relevant Authors

The *Authors' Production Over Time* plot provides a dynamic overview of the publication trends and impact of key contributors within the research field of environmental behavior and waste management. Through the visualization of horizontal timelines, bubble sizes, and color intensity, we gain insights not only into the consistency of authors' publication activity but also the scholarly impact of their work, as indicated by citation counts in specific years (Fig.4).

Among the most prominent contributors is Wang Y, whose recent surge in activity between 2021 and 2023 is matched by high citation counts, suggesting a significant influence on the field. His highly cited publication on *green finance and farmer environmental behavior* positions him at the intersection of behavioral economics and environmental policy. Similarly, Li J demonstrates sustained productivity beginning around 2018, with notable research exploring *waste sorting behavior* and *construction waste reduction* using the Theory of Planned Behavior. Wang X also stands out for a steady stream of publications between 2016 and 2023, focusing on niche yet increasingly relevant topics like *e-waste recycling* and *reusable express packaging* areas gaining traction in sustainability discourse.

Zhang Y and Liu X are notable for their more recent entries into the field, primarily publishing between 2021 and 2023, yet their work centered on *household waste separation* and *energy conservation behavior* respectively has already received significant recognition. Meanwhile, Zhang J has maintained consistent output since 2018, focusing on tourism-related environmental challenges, while Wang J has similarly shown robust engagement from 2019 onward, particularly in studies of *waste separation behavior*. Wang Z, with a peak period around 2018–2019, contributed important studies on *online recycling behaviors* and the impact of *information publicity* on recycling participation.

A distinctive case is Agovino M., whose publications are concentrated between 2015 and 2019 and offer a more regionally focused perspective, analyzing *waste management performance* and the influence of *cultural factors* in the Italian context. Zhang L, with activity peaking in 2019 and 2021, addresses *pro-environmental behavior* in agricultural settings, particularly the issue of *mulch film pollution*.

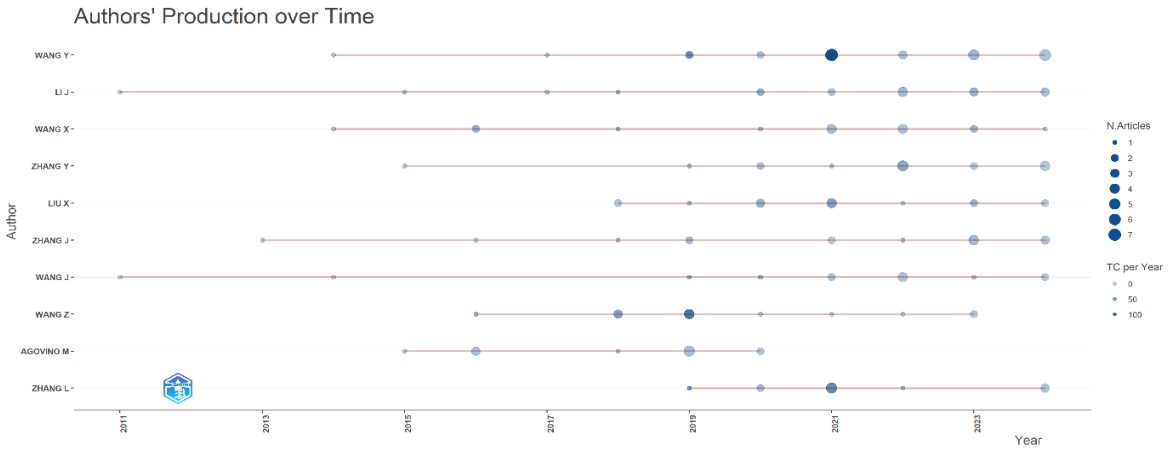

Figure 4. Most Relevant Authors

3.7 Author Productivity through Lotka's Law

The graph titled *"Author Productivity through Lotka's Law"* illustrates the distribution of author productivity within the dataset, following the inverse-square principle proposed. Alfred J. Lotka (1926) proposes the law which explain the productivity distribution of authors in the dataset describes the inverse relationship between the number of authors and their publication count. According to this law, a small proportion of authors are responsible for a large share of publications, while the majority contribute only a single work. This pattern is clearly evident in the graph, where the steep initial slope indicates that more than 80% of authors have authored only one document (Fig.5). As the number of documents increases along the x-axis, the curve flattens significantly, highlighting the presence of a few highly productive authors. The solid line represents the observed data, while the dashed line likely reflects the theoretical distribution predicted by Lotka's Law, showing a strong alignment between empirical trends and theoretical expectations. This distribution confirms the skewed authorship structure typical in scholarly fields, where research output is heavily concentrated among a small group of core contributors, reinforcing the need to recognize both the breadth of participation and the depth of influence in academic publishing.

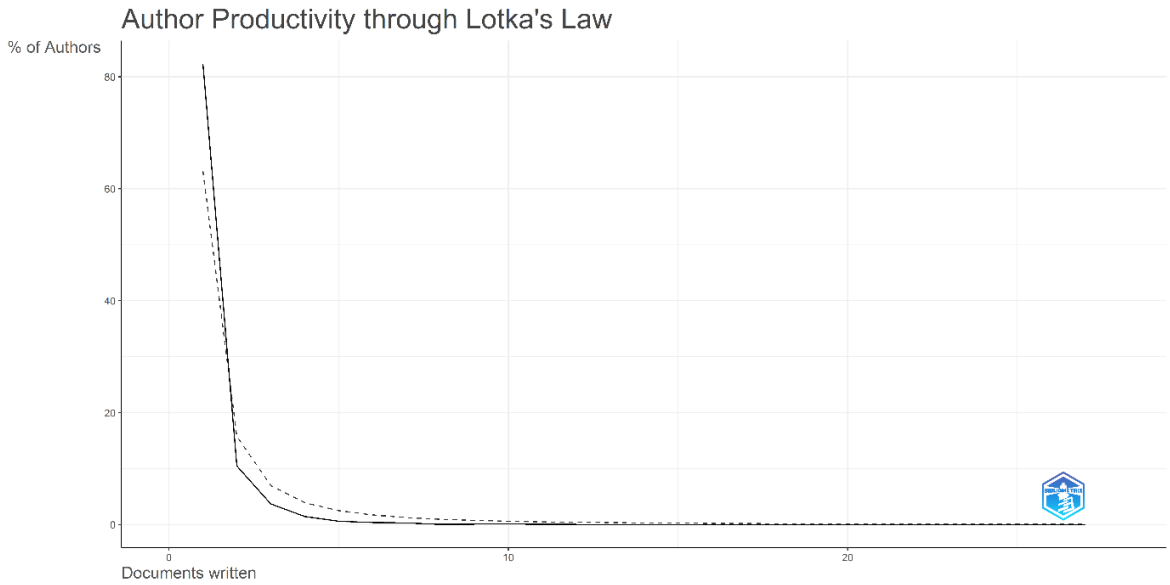

Figure 5. Author Productivity through Lotka's Law

3.8 Most Relevant Affiliations

The data on institutional affiliations reveals the most prolific research institutions contributing to the field of environmental behavior, waste management, and sustainability studies. At the top of the list is the Chinese Academy of Sciences, leading with 36 articles, showcasing China's robust investment in environmental research and its growing global footprint in scholarly output. This is followed closely by the University College London (UCL) with 34 articles, reflecting the UK's strong academic infrastructure and UCL's emphasis on interdisciplinary sustainability research.

Two institutions are tied with 26 publications each: the Beijing Institute of Technology and the University of California system. Their presence underscores both China's and the United States' strategic commitment to research in environmental behavior and technology-driven waste solutions. The Hong Kong Polytechnic University, with 24 articles, also stands out, representing Asia's significant contributions in applied environmental research, particularly in urban waste management and behavior change interventions.

Other institutions such as the University of London (22), University of British Columbia (21), and University of South Australia (21) highlight a strong participation from English-speaking countries with a history of policy-relevant and community-focused environmental research.

Similarly, Zhejiang University (21) and Imperial College London (20) reinforce the role of top-tier universities in China and the UK in advancing innovative and high-impact environmental research agendas.

This list reflects a geographically diverse and internationally collaborative research ecosystem, with prominent representation from Asia, Europe, North America, and Oceania. These institutions act as hubs for academic leadership, influencing both policy and practice through their sustained contributions to the field.

3.9 Corresponding Author's Countries

A comprehensive analysis of the *Corresponding Author's Country Collaboration Plot* reveals significant patterns in global research output and collaboration within the domain of psychological interventions and waste management. This visualization ranks countries based on the number of scientific publications in which the corresponding author is affiliated with a particular country and distinguishes between Single Country Publications (SCP) and Multiple Country Publications (MCP) (Fig.6).

China emerges as the most prolific contributor in this research area, producing 344 publications, which indicates a strong national investment in environmental psychology and behavioral approaches to waste management. In comparison, the United States and the United Kingdom follow with 184 and 150 publications respectively. While they produce significantly fewer publications than China, their presence confirms the strength of their *established research infrastructures* and continued interest in sustainability-related behavioral studies.

The analysis of international collaboration levels based on the MCP Ratio reveals intriguing patterns. Pakistan displays the highest MCP ratio at 33.3%, suggesting a notable reliance on *international partnerships* possibly due to limited domestic research facilities or a deliberate strategy to integrate with global scholarly networks. Similarly, Japan (25%), Korea (22.2%), Germany (22%), and Lithuania (21.7%) exhibit relatively high MCP ratios. These values may reflect either *a dependence on cross-border collaboration* to enhance research quality or *a policy-driven effort* to maintain strong international academic ties.

In contrast, countries such as France (4.3%) and Indonesia (5.1%) report the lowest MCP ratios, indicating a heavier reliance on domestic research collaborations. This pattern may result from national research policies, funding structures, or self-sufficient institutional capacities that prioritize local rather than international partnerships. Interestingly, China, despite being the most productive country, maintains a relatively low MCP ratio of 19.8%. This suggests that a large share of its research is conducted within its own borders, likely due to its *expansive and well-supported national research ecosystem* as well as a possible focus on solving country-specific environmental challenges.

The United States (11.4%) and United Kingdom (13.3%) follow a similar pattern. Although both countries are global research leaders, their MCP ratios remain modest, implying that their researchers are primarily engaged in collaborations within national boundaries. This could be attributed to their *mature academic systems* and *substantial domestic funding*, which support the production of high-quality research without the need for extensive international collaboration.

On the other hand, countries such as Pakistan, Japan, Korea, Germany, and Lithuania with higher MCP ratios seem to be actively leveraging international networks to enhance their research impact. These collaborations may offer access to *advanced methodologies*, *technical resources*, or *thematic expertise* that are not readily available locally. High MCP ratios may also reflect efforts to *increase global visibility* and *citations*, particularly for emerging or mid-sized research economies.

The country collaboration patterns highlight important differences between *quantitative productivity* and *qualitative engagement*. While countries like China, the USA, and the UK lead in publication volume, others like Pakistan, Japan, and Germany exhibit a more globally integrated research profile.

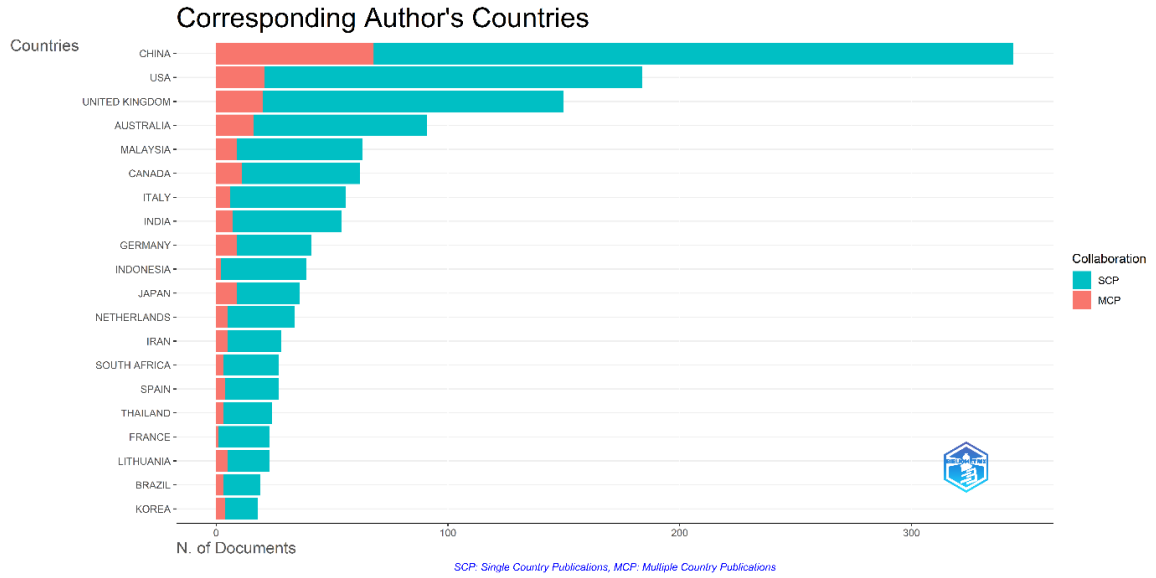

Figure 6. Corresponding Author's Countries

3.10 Countries' Scientific Production

The data on countries' scientific production reveals significant geographic patterns in research output related to environmental behaviour and waste management. China leads overwhelmingly with 749 publications, reflecting its substantial investment in environmental research and policy-driven initiatives to address waste issues domestically. Following China, the United Kingdom and the United States contribute 365 and 355 publications respectively, demonstrating their long-standing academic infrastructure and strong focus on behavioural and environmental sciences. Australia (173 publications) and Canada (125) also emerge as active contributors, likely influenced by their national sustainability agendas and robust university research programs. Among Asian countries, Malaysia stands out with 110 publications, indicating rising scholarly attention to environmental concerns in Southeast Asia. Italy and India, with 103 and 101 publications respectively, show notable engagement from Europe and South Asia. Meanwhile, Germany (84) and the Netherlands (82) represent well-established European research centers that maintain a steady contribution to the field. Overall, the data reflect a global distribution of scientific effort, with both developed and emerging nations playing key roles in advancing research on pro-environmental behaviour and waste management.

3.11 Most Cited Countries

The data on most cited countries offers a nuanced understanding of not just research productivity but also the impact and influence of that research within the academic community. While China leads in total publications, with 12,747 total citations across its articles, the average citation per article is 37.10, indicating broad but relatively moderate impact per paper (Fig.7). In contrast, the United Kingdom achieves 11,967 citations with only half the number of articles compared to China, resulting in a significantly higher average of 79.80 citations per article, highlighting the high quality and influence of UK-based research.

Similarly, the USA records 9,582 citations and an average of 52.10 citations per article, reinforcing its position as a major contributor of impactful studies. Germany, despite fewer articles, stands out with an exceptional average of 135.50 citations per article, the highest among all countries listed, indicating landmark or foundational publications that have shaped the field. Sweden also displays impressive influence, with an average of 99.20 citations per article, suggesting that although its publication volume is lower, the research output is highly valued and widely referenced.

Australia and Canada exhibit strong citation performances as well, with average article citations of 66.10 and 74.70, respectively, indicating consistent production of highly relevant

research. The Netherlands, with an average of 85.70 citations per article, further emphasizes the significance of its contributions, likely reflecting collaborative and interdisciplinary work. While Italy and Malaysia show lower averages (44.40 and 38.60 respectively), they still contribute meaningfully to the global research dialogue.This citation analysis demonstrates that while some countries dominate in terms of quantity, others distinguish themselves through depth, rigor, and scholarly impact, positioning them as thought leaders in the domains of environmental behaviour and waste management.

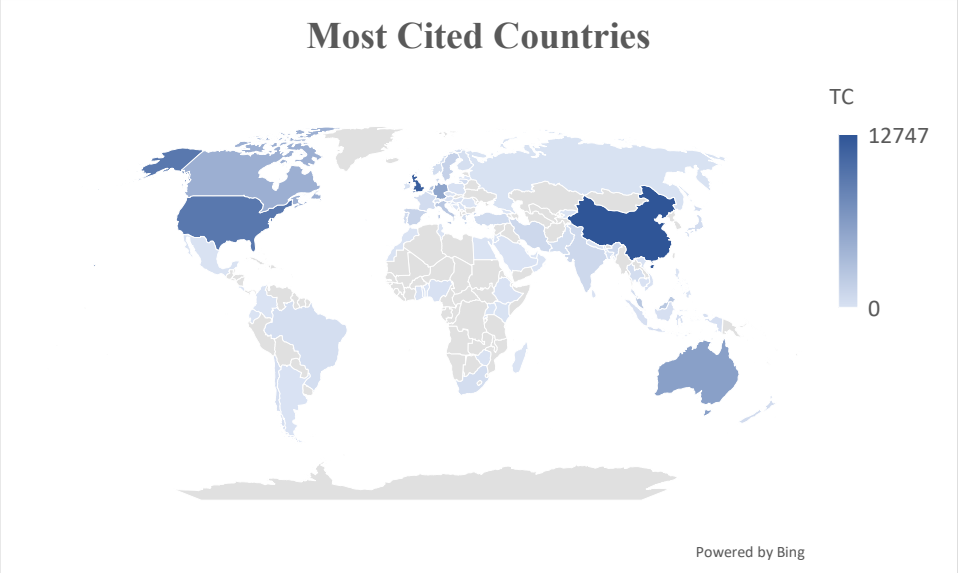

Figure 7. Most Cited Countries

3.12 Most Global Cited Documents

The table highlights the top 10 most cited papers in the field of environmental psychology, waste management, and pro-environmental behavior, based on total citation counts. At the top of the list is the landmark paper by [17] published in *Science*, with an outstanding 9176 citations, underscoring its foundational role in global plastic waste research and policy discourse (Tab.1). This paper alone demonstrates the scale of academic and policy influence stemming from high-impact publications.

Closely following are several highly influential works in the field of behavioral and environmental psychology. [12] in *Journal of Environmental Psychology* and [2] in *The Lancet* have garnered 2456 and 1899 citations, respectively, reflecting the interdisciplinary interest in human-environment interactions and global health. Whitmarsh (2010), another major contribution in environmental psychology, focuses on climate change behavior and perceptions, with 1104 citations, indicating its strong academic uptake.

Further down the list, classic behavioral studies like [18] and [1] remain influential, with nearly 1000 and 913 citations respectively, showing the long-term academic relevance of foundational psychological models such as the Theory of Planned Behavior and Value-Belief-Norm Theory. These are often cited in studies that explore determinants of environmentally responsible behaviors.

The inclusion of [2], [10] shows the applied dimension of this literature—covering topics from recycling behaviors to municipal waste management and social norms. These articles have between 600–800 citations, indicating their practical value for both researchers and policymakers.

This list of top-cited works provides a concise overview of the core intellectual contributions shaping the academic discourse in environmental behavior and waste management. These studies not only inform theoretical development but also guide empirical interventions, sustainability strategies, and environmental governance globally.

Table 1. Most Global Cited Documents

Paper	DOI	Total Citations
JAMBECK J, 2015, SCIENCE	10.1126/science.1260352	9176
BAMBERG S, 2007, J ENVIRON PSYCHOL	10.1016/j.jenvp.2006.12.002	2456
WHITMEE S, 2015, LANCET	10.1016/S0140-6736(15)60901-1	1899
WHITMARSH L, 2010, J ENVIRON PSYCHOL	10.1016/j.jenvp.2010.01.003	1104
GUAGNANO G, 1995, ENVIRON BEHAV	10.1177/0013916595275005	984
TERRY D, 1999, BR J SOC PSYCHOL	10.1348/014466699164149	913
TONGLET M, 2004, RESOUR CONSERV RECYCL	10.1016/j.resconrec.2003.11.001	785
BAMBERG S, 2003, ENVIRON BEHAV	10.1177/0013916502250134	684
HARLAND P, 1999, J APPL SOC PSYCHOL	10.1111/j.1559-1816.1999.tb00123.x	629
MARSHALL R, 2013, WASTE MANAGE	10.1016/j.wasman.2012.12.023	627

3.13 Most Frequent Words

The analysis of the most frequent words in the dataset offers valuable insight into the dominant themes and conceptual focus of the research field. The term *"recycling"* appears most frequently, with 411 occurrences, highlighting its central role in the discourse around environmental behavior and waste practices (Fig.8). Closely following is *"waste management"* with 400 occurrences, indicating its importance as both a practical and policy-oriented area of study. The prominence of *"pro-environmental behavior"* (369 occurrences) and *"theory of planned behavior"* (314 occurrences) reflects a strong theoretical grounding in behavioral science, particularly in understanding individual and collective actions toward sustainability. The recurring appearance of both *"planned behavior"* and *"attitudes"* suggests continued reliance on behavioral models to interpret environmental engagement. Additionally, terms like *"human"* and *"article"*, though more general, indicate the human-centered and empirical nature of much of the research. The frequent mention of *"behavior change"* (248 occurrences) and *"recycling behavior"* (233 occurrences) further reinforces the focus on modifying individual practices through targeted interventions. Collectively, these terms reveal a research landscape deeply engaged with psychological frameworks, behavioral interventions, and practical strategies to improve waste-related practices.

Figure 8. Most Frequent Words

3.14 Trend Topics

The analysis of *trend topics* offers a dynamic overview of the evolution of research themes over time within the intersection of psychological approaches and waste management. The timeline

spans from the early 1990s to 2024, although notable activity begins primarily after the mid-2000s. This temporal mapping is valuable in distinguishing between emerging research fronts and established thematic areas. The size of the bubbles on the plot represents the frequency of keyword occurrence in a given year, while the horizontal range reflects the spread of those occurrences, allowing an assessment of both prominence and variability in usage.

In recent years, there is a marked rise in environmentally oriented keywords, denoting a shift toward sustainability-focused research. Terms such as "ecosystem," "challenges," "plastic pollution," "carbon footprint," "intention," "circular economy," "waste management," and "pro-environmental behavior" have surfaced prominently, with relatively large bubble sizes. This indicates not only their frequent use in current literature but also their growing centrality to scholarly discourse. Their emergence suggests a response to *contemporary global environmental challenges*, and the integration of *psychological determinants* in tackling issues like pollution, waste reduction, and sustainable consumption.

In the mid-2010s, there is evidence of increased interest in the social and behavioral dimensions of environmental management. Keywords such as "human," "household waste," "policy," "participation," "values," "habit," and "social behavior" began to feature more prominently, reflecting a disciplinary shift from purely technical or infrastructural perspectives to more people-centered frameworks. These trends indicate a maturing of the research field, where *behavioral psychology*, *community engagement*, and *value systems* are being recognized as critical components of effective waste management strategies.

Earlier entries in the trend timeline reveal a geographic or regional orientation in research. Terms such as "Western Europe," "Eurasia," and "England" appeared in the 2006–2012 period, possibly pointing to region-specific case studies or early adopters of sustainability-focused behavioral research. These terms may also reflect the geographies where funding, awareness, or institutional interest in environmental psychology and waste issues first gained traction.

One particularly interesting observation is the appearance of the term "priority journal", which does not refer to a thematic concept but rather to the *meta-analysis of publication strategies* or *journal targeting practices*. Its presence could indicate research interest in *scholarly communication*, *impact factor dynamics*, or the strategic positioning of research for greater visibility in high-priority outlets.

The *trend topics plot* provides a clear illustration of how research focus has evolved from *region-specific studies* and *technical waste management* to *behavioral interventions*, *sustainability strategies*, and *global environmental themes*.

3.15 Co-occurrence Network

The *co-occurrence network analysis* offers a rich and visually compelling overview of the intellectual structure of research at the intersection of psychology and waste management.

The network is built using the “association” normalization method, which adjusts for the frequency of individual keywords while highlighting terms that co-occur more frequently than expected by chance. This technique allows for the detection of meaningful conceptual linkages between research terms. Keyword co-occurrence patterns are organized using the walktrap algorithm, a reliable community detection approach that identifies clusters based on short random walks across the network graph. The resulting visualization, enhanced by variations in node size, label scale, edge transparency, and thickness, reveals the structural layout of thematic communities within the dataset (Fig.9).

Three major thematic clusters are visible, each represented by a distinct color green, red, and blue corresponding to different research communities.

The green cluster is primarily concerned with *human behavior and methodological aspects of waste management research*. This cluster includes terms such as “humans,” “male,” “female,” “adult,” and “questionnaire,” pointing to a demographic and empirical focus. The presence of the keyword “article” further implies a dominance of *original empirical studies* over theoretical or review-based

publications. Crucially, this cluster is also linked to "behavior change" and "waste disposal," indicating a strong focus on *how individual or household-level behaviors influence waste-related outcomes*.

The red cluster revolves around the more traditional topics of "waste management" and "recycling," and it integrates key theoretical constructs such as the "theory of planned behavior," "attitude," and "intention." These terms suggest that the studies within this cluster frequently apply psychological theories to understand waste-related behaviors. Furthermore, the appearance of keywords like "sustainability," "circular economy," and "food waste" implies a broader environmental framework, incorporating both policy-relevant and applied sustainability themes. The linkage to food waste also points to a currently emerging subtopic within this thematic area.

The blue cluster is centered on "pro-environmental behavior," "planned behavior," and "attitudes," representing a conceptual space focused on understanding the *psychological determinants* of environmentally responsible action. The presence of "determinants" in this cluster emphasizes the goal of identifying the *underlying factors* that drive pro-environmental choices. This cluster reflects the integration of theoretical modeling with behavioral outcomes, providing insight into the mechanisms that encourage sustainable practices.

An analysis of centrality indicated by node size highlights several key concepts. "Waste management" emerges as the most central term, affirming its foundational role in the field. "Human" is also a central node, suggesting that the field has a strong methodological orientation toward empirical, human-subject-based studies. Similarly, "theory of planned behavior" stands out as a highly connected term, reaffirming its status as a widely used and influential theoretical model in the context of behavioral environmental research. Other prominent nodes include "recycling," "pro-environmental behavior," "planned behavior," and "article," the latter further supporting the observation that much of the research in this domain is based on primary data collection and analysis rather than conceptual or review work.

The co-occurrence network reveals a field that is thematically diverse yet interconnected. The three major clusters spanning demographic-behavioral studies, theoretical applications, and pro-environmental determinants highlight the multidimensional nature of psychological research in waste management.

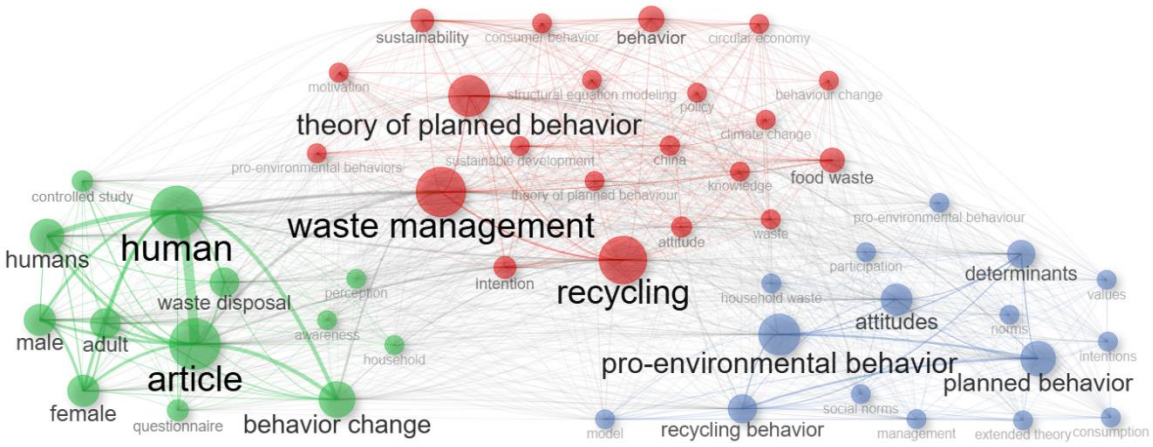

Figure 9. Co-occurrence Network

3.16 Thematic Map

The thematic map described provides a strategic visualization of how various research themes are positioned within the academic landscape based on their centrality (relevance to the field) and density (level of development). The four quadrants Motor Themes, Basic Themes, Niche Themes, and Emerging or Declining Themes help us understand both the maturity and influence of different clusters.

At the core of the research field, located in the Motor Themes quadrant (upper-right), lies the cluster centered on "Recycling," "Pro-Environmental Behavior," and "Sustainability"(Fig.10). These themes are both highly relevant (central) and well-developed (dense), making them the driving forces in this domain. The prominence of articles from authors like *Njoku A (2024)* and *Costa A (2022)* in leading sustainability journals confirms their dominance and maturity. This suggests a consolidated research front focused on sustainable behavior and environmental responsibility.

In contrast, the Basic Themes quadrant (lower-right) houses clusters like "Theory of Planned Behavior (TPB)," "Attitude," and "Recycling Behavior". These are foundational to the field closely tied to the core but not yet as developed. High-impact contributions from works like *Emmanouil C (2024)* and *Chu P (2006)* indicate that while these topics are heavily cited and influential, they may still require further expansion or interdisciplinary linkage to evolve into motor themes.

Closer to the center of the map are themes that are moderately developed and moderately central. Clusters like "Plastic Pollution and Marine Litter," "COVID-19," and "Environmental Behavior with Personal Norms and Solid Waste" fall here. Their position reflects growing interest but comparatively less maturity. These are likely emerging areas where research is increasing especially around pandemic-related waste or newer forms of pollution but they have yet to become fully established themes across the discipline.

In the Emerging or Declining Themes quadrant (lower-left), we find clusters such as "Nudging," "Reverse Logistics," and "Sanitation". These themes are currently underdeveloped and not yet central. This positioning could either signal that they are nascent, underexplored opportunities for future work or that they represent areas that failed to sustain attention. The low page rank scores suggest these topics have not yet garnered significant academic traction, although they may hold potential for expansion, particularly as policy-oriented or behavioural tools in waste management and sustainability.

The Niche Themes quadrant (upper-left) includes "System Dynamics and Environmental Health" as well as "SEM (Structural Equation Modeling)." These topics are well-developed technically and methodologically, but are less integrated with other mainstream themes in the field. Their isolated yet mature status implies they are specialized tools or sub-fields with depth but limited cross-disciplinary engagement.

The theme "Pro-Environmental Behaviors", located near the center of the map, suggests it is a growing but not yet dominant concept. Its positioning may reflect the field's evolving focus on behavioural interventions and ecological citizenship, bridging foundational theories and applied sustainability actions. The thematic map paints a dynamic picture of the research field: while some clusters are mature and central, driving scholarly dialogue, others are still developing or on the periphery, offering avenues for future exploration or indicating shifts in academic and practical relevance.

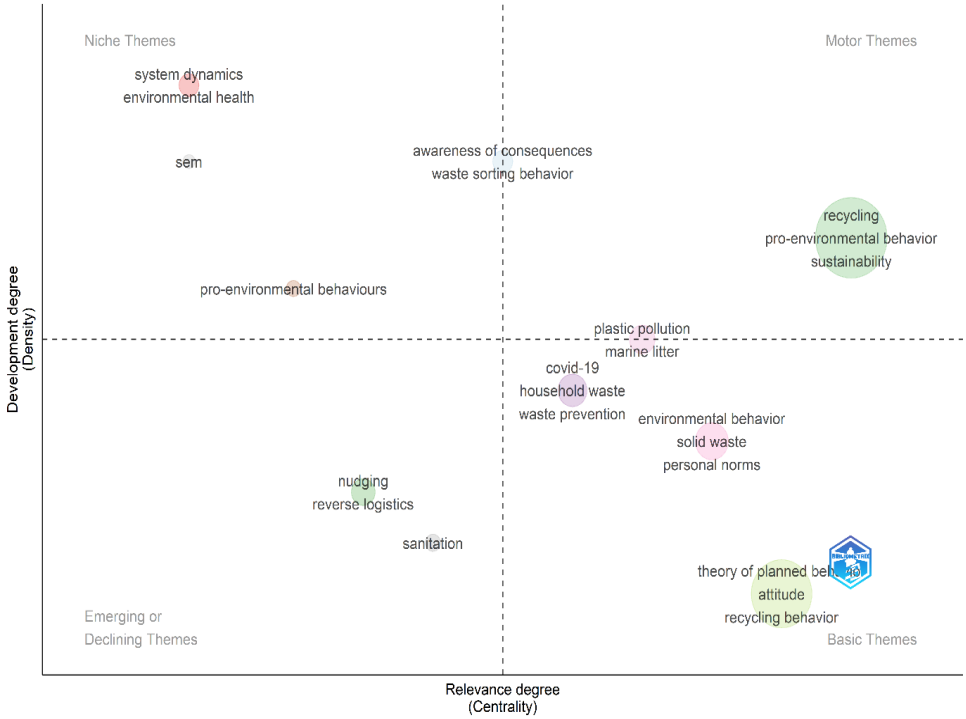

Figure 10. Thematic Map

3.17 Thematic Evolution

The *thematic evolution* of research within the domain of environmental psychology and waste management reveals a dynamic transformation in both content and methodological approaches over time. By examining keyword transitions and strategic mappings across four distinct periods (1992–1999, 2000–2009, 2010–2019, and 2020–2024), the field's shifting priorities and conceptual foundations become evident. The analysis, enriched by the *Sankey diagram* and *strategic thematic maps* (Fig.11), offers insight into how research foci have expanded from basic behavioral constructs to complex, systems-oriented investigations.

In the early phase (1992–1999), the thematic structure was rooted in broad psychological constructs such as "attitudes," "behavior," "norms," and "participation." These keywords dominated the landscape, reflecting an early-stage focus on understanding the cognitive and normative drivers of environmental action. The *motor themes* during this period "attitudes," "reasoned action," and "program" indicate a strong foundation in behavioral theory, particularly frameworks such as the Theory of Reasoned Action. However, the relative absence of keywords in the *niche* and *basic themes* quadrants suggests that the field was still in its conceptual infancy, lacking specialization or foundational coherence beyond core psychological models.

Between 2000 and 2009, the field began to diversify. Keywords such as "air pollution," "recycling," "ecosystems," "consumption behavior," "solid waste management," and "pro-environmental behavior" emerged, marking a shift from general behavioral inquiry to specific environmental applications. The appearance of "article" as a dominant keyword points toward an increase in empirical, publication-focused research. In this period, *motor themes* such as "waste disposal," "sanitation," "recycling," and "human" demonstrate a growing interest in practical public health concerns and human-environment interactions. *Basic themes* like "model" and "coherent behavior" reflect the gradual introduction of theoretical and conceptual modeling, while *emerging themes* such as "life cycle," "consumption behavior," and "solid waste management" signal the beginning of interdisciplinary expansion. Specialized topics in the *niche quadrant*, such as "Hepatitis-C" and "infection," suggest isolated yet relevant research linking environmental and public health outcomes.

The period from 2010 to 2019 saw the consolidation of environmental psychology as a structured and theory-driven field. Core themes such as "waste management," "behavior change," and "article" persisted as *motor themes*, indicating their continued relevance. More importantly, *basic themes* like "sustainability" and "theory of planned behavior" gained prominence, reflecting a deepening theoretical orientation and long-term environmental outlook. This period also saw the emergence of new research frontiers, with terms such as "future," "computational methods," and "non-human" appearing as *emerging or declining themes*. These suggest growing interest in *forecasting models*, *technological interventions*, and *post-humanist ecological concerns*. Meanwhile, *niche themes* such as "lead" and "non-human" represent an expanding focus on environmental toxicity and ecological actors beyond the human domain.

In the most recent period, 2020 to 2024, the field has shown further methodological and conceptual sophistication. Dominant *motor themes* such as "waste management," "recycling," and "human" confirm the enduring relevance of applied behavioral solutions to environmental challenges. At the same time, *basic themes* including "attitudes," "sustainability," "behavior," and "theory of planned behavior" continue to serve as conceptual anchors. The rise of "SEM (Structural Equation Modeling)" as an *emerging theme* suggests increasing methodological rigor and a shift toward the use of advanced statistical modeling techniques to explore complex behavioral-environmental interactions. Additionally, the presence of *niche themes* such as "non-human" and "animal" further reinforces the trend toward ecological complexity, where *non-human actors* (animals, ecosystems, pollutants) are seen as integral to environmental outcomes.

Taken together, these thematic shifts highlight several key developments in the field. First, there is a clear evolution from general attitudes and normative models to more specific practices such as waste segregation, recycling, and sustainable behavior. Second, the growing inclusion of *non-human* themes reflects a paradigmatic shift toward ecocentric and multispecies perspectives, which align with contemporary discussions in environmental humanities and post-anthropocentric studies. Third, the emergence of advanced methodologies such as SEM indicates a move toward greater analytical precision, allowing scholars to model complex relationships between psychological constructs and environmental behaviors. Fourth, the consistent presence and increasing centrality of the Theory of Planned Behavior underscores its status as a foundational theoretical framework, serving as a conceptual bridge across all periods of thematic development.

The *strategic maps* offer insight into the strategic importance and maturity of these themes over time. *Motor themes*, located in the upper right quadrant, represent topics that are both *central and well-developed*, making them key areas of impactful research. These include waste management, recycling, and behavior change, which continue to anchor scholarly engagement. Meanwhile, *emerging and declining themes* offer a preview of where the field may be heading, and which topics require further development to become mainstream. As the field continues to evolve, these thematic patterns offer valuable guidance for future research directions, especially for scholars interested in linking *behavioral science*, *environmental policy*, and *sustainability strategies* within a unified interdisciplinary framework.

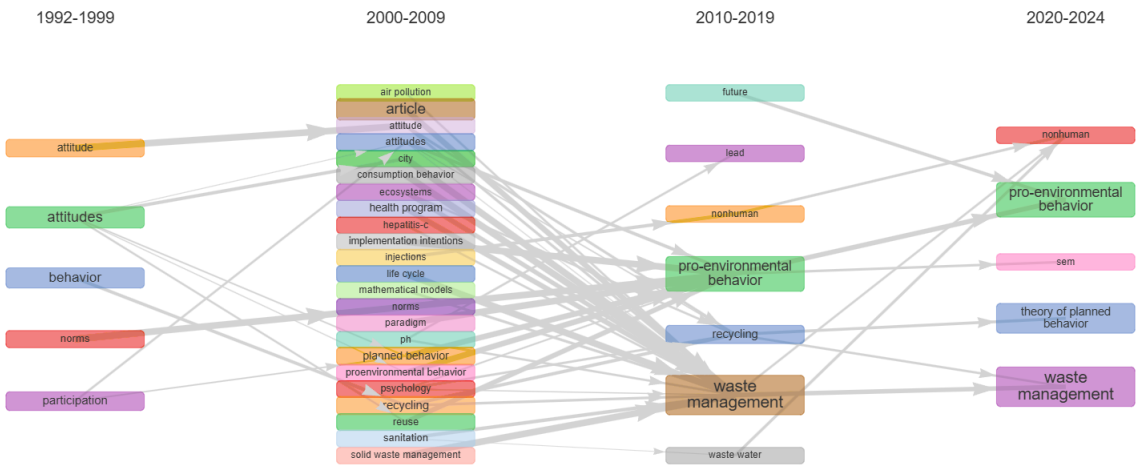

Figure 11. Thematic Evolution

3.18 Factorial Analysis

The *factorial analysis* conducted through Multiple Correspondence Analysis (MCA) provides a valuable lens to examine the conceptual structure of research in psychological interventions and waste management. MCA is particularly suited for exploring categorical data such as keywords, and it allows for the reduction of multidimensional information into a simplified, interpretable two-dimensional space (Fig.12).

Dimension 1 explains a substantial portion of the total variance 87.79% indicating that the horizontal axis captures the most dominant pattern in the dataset. In contrast, Dimension 2 accounts for just 7.7%, suggesting that the vertical axis offers only marginal additional explanatory power. This stark imbalance implies that *most of the thematic differentiation among keywords occurs along the horizontal plane*, and interpretations should give greater weight to this axis. It is worth noting that the absence of *cited references* in the dataset due to limitations in the merged bibliographic format may somewhat constrain the interpretive richness of the MCA results, particularly in fields where citation patterns are tightly coupled with keyword usage.

While no formal cluster boundaries are visually demarcated in the MCA plot, visual inspection reveals three loosely defined thematic zones based on the placement of keywords across Dimension 1. On the left side (negative Dim 1), the map clusters terms such as “extended theory,” “planned behavior model,” “norms,” “theory of planned behavior,” “circular economy,” and “policy.” This side reflects a theoretical and policy-oriented focus, emphasizing conceptual frameworks and normative structures that shape environmental behaviors. The prominence of these terms and their distance from the origin suggest that they are highly distinctive and carry strong thematic weight in defining the intellectual foundation of the field.

In contrast, keywords located near the center of the map, around the origin, tend to be general and foundational within the research landscape. Terms like “attitude,” “sustainability,” “waste management,” “behavior,” “knowledge,” and “food waste” are positioned in this neutral zone. Their central location indicates that these are widely used, cross-cutting concepts relevant to multiple subfields and not uniquely associated with any one dimension. These terms likely form the *core vocabulary* of the research community and serve as bridges between specialized topics.

The right side of the MCA plot (positive Dim 1) is associated with an empirical and demographic research focus. Here, we find keywords such as “questionnaire,” “survey,” “controlled study,” “female,” “humans,” “household,” “waste disposal,” and “behavior change.” These terms point toward studies that rely on quantitative data collection methods, including survey instruments and structured experimental designs. The presence of demographic indicators such as “female” and “human” suggests a strong interest in population-specific behavioral interventions. This cluster

reflects the applied, data-driven dimension of the research, concerned with measuring, modeling, and changing real-world environmental behavior through empirical methodologies.

Taken together, the MCA map reflects a clear divide between theoretical/policy-driven scholarship and empirical/applied research. On one end, scholars are deeply engaged in building and refining conceptual frameworks like the Theory of Planned Behavior and investigating structural drivers such as environmental policy and circular economy models. On the other end, a strong empirical tradition is evident grounded in human-subject studies, behavior change programs, and methodological rigor. The central cluster acts as a conceptual bridge, housing general environmental behavior constructs that support and connect both the theoretical and applied ends of the spectrum.

The limited explanatory power of Dimension 2 (7.7%) should caution researchers against overinterpreting vertical differences in the map. However, some meaningful contrasts still emerge. Keywords with higher values on Dim 2, such as "extended theory" and "planned behavior model," are more closely aligned with abstract or theoretical orientations, while those with lower Dim 2 values lean toward generalist or applied concerns, such as "sustainability" and "recycling." Additionally, the filtering parameter of min Degree: 59 ensures that only frequently occurring terms are included in the analysis. While this helps focus attention on dominant themes, it may also exclude important yet *emerging or niche keywords* that appear in fewer documents. Varying this threshold in future iterations could yield alternative perspectives on underexplored research areas.

The factorial analysis reveals a *conceptually stratified research field* ranging from abstract theoretical models to grounded empirical inquiries with general behavioural constructs acting as thematic linkages. The visualization reinforces the notion that environmental behavioural research is inherently interdisciplinary, combining psychological theory, policy analysis, and methodological innovation.

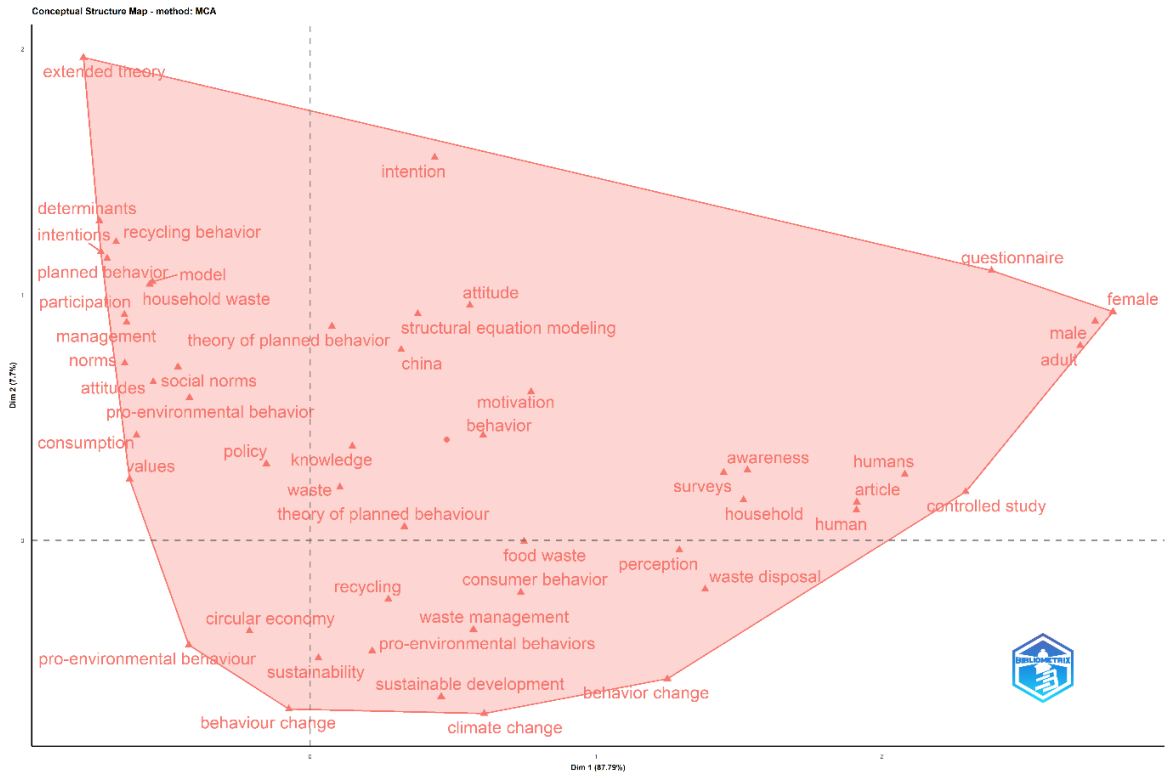

Figure 12. Factorial Analysis

3.19 Collaboration Network

The *collaboration network* derived from the dataset reveals a moderately dense structure of international scientific cooperation in the field of psychological interventions and waste management (Fig.13). The presence of both well-connected hubs and loosely attached or isolated countries suggests an uneven distribution of collaborative activity, with some nations serving as central connectors while others remain at the periphery of the global research network.

Among the most central nodes, the United Kingdom and China stand out prominently. Their node size, determined by degree centrality, reflects the number of direct collaborative links these countries maintain with others. Their dominance in the network indicates that both countries play a pivotal role as international research hubs, facilitating the flow of knowledge and multi-national engagement. The United Kingdom, known for its long-standing academic institutions and robust funding systems, and China, which has dramatically increased its investment in research and development in recent decades, appear to act as strategic anchors in the collaboration landscape.

The network also exhibits a distinct community structure, revealed by the coloring of nodes through Walktrap clustering. These communities not only reflect geographic proximity but also thematic alignment or shared research priorities. The blue cluster, the most densely connected and extensive community, is centered around the United Kingdom and China. It includes influential collaborators such as the Netherlands, Singapore, Australia, and Switzerland, forming a vibrant network that spans Europe, Asia, and Oceania. This cluster likely reflects research partnerships built on shared environmental concerns, policy interests, and access to funding mechanisms from international bodies or regional consortia.

In contrast, the red cluster represents a group of countries primarily drawn from Latin America and Southern/Western Europe, including Brazil, Mexico, Spain, Italy, Germany, France, Russia, and Chile. These countries likely collaborate due to historical ties, linguistic similarities, and regional environmental challenges, particularly in urban waste management and sustainability. The presence of major European nations also suggests intra-regional cooperation within frameworks such as the European Union's Horizon research programs.

The green cluster, which includes countries such as Romania, Iran, Belgium, and Indonesia, appears to be less defined and more emergent. These countries may be developing new research links around niche topics or through targeted bilateral agreements. While they are not central to the network, their participation signals growing engagement in international scientific discourse, particularly as developing nations seek to expand their research visibility and capacity.

Two smaller clusters the purple cluster (including Turkey and Norway) and the orange cluster (Serbia and Colombia) are relatively weakly integrated into the core network. These nations may either focus on regionally specific research agendas or face structural barriers to international collaboration, such as limited research funding, language constraints, or geopolitical factors. Nonetheless, their presence in the network highlights opportunities for future integration and partnership-building, especially in addressing shared global challenges like environmental degradation and behavioral change.

The central positioning of countries such as the United Kingdom and China can be interpreted through multiple lenses. Firstly, these nations are likely major research producers, hosting world-class universities, research institutions, and funding mechanisms that make them attractive collaboration partners. Secondly, both countries have strategic interests in global scientific leadership, actively promoting international research partnerships through governmental and institutional policies. Lastly, their prominence in the network could reflect the influence and citation impact of their research outputs, drawing collaboration from other countries seeking intellectual exchange or co-authorship opportunities with high-impact institutions.

The collaboration network provides a detailed map of the global research connectivity within the field. While major hubs like the UK and China dominate the landscape, the presence of smaller, emerging clusters and underconnected nations suggests that there is room for greater

inclusivity and strategic partnership-building. Encouraging cross-cluster interactions and supporting the integration of peripheral countries can enhance the diversity and reach of research on environmental behavior and waste management. Future studies may explore temporal changes in collaboration patterns or assess how institutional partnerships influence thematic and methodological convergence across countries.

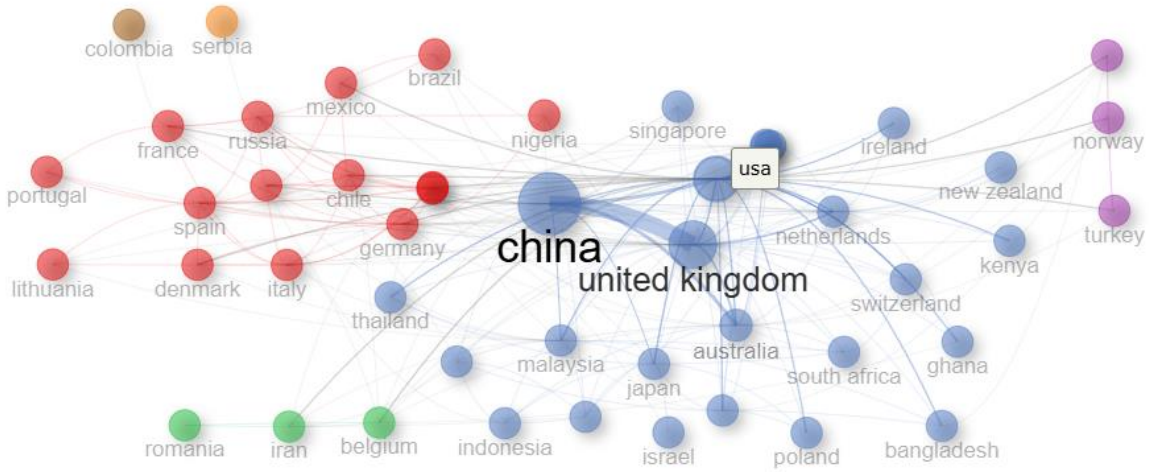

Figure 13. Collaboration Network

CONCLUSION

This bibliometric analysis offers a comprehensive overview of the evolving scholarly landscape at the intersection of behaviour change, psychological intervention and waste management. Over the past three decades, research output in this domain has grown exponentially, especially in the last decade, reflecting increasing global recognition of the critical role human behaviour and psychological factors play in achieving sustainable waste practices. Core journals such as Sustainability, Journal of Cleaner Production, and Waste Management have emerged as primary outlets for disseminating interdisciplinary findings, emphasizing the thematic convergence of environmental science, behavioural psychology, and policy research.

Geographic trends reveal that countries like China, the United Kingdom, and the United States are leading contributors, supported by strong academic infrastructure and policy-driven research agendas. However, the growing participation of emerging economies such as Malaysia, India, and Brazil indicates a widening global engagement in addressing environmental challenges through behavior-focused research. Thematic evolution, as captured through trend analysis and factorial mapping, shows a clear shift from technical and region-specific studies to broader, people-centered approaches, highlighting constructs such as pro-environmental behavior, circular economy, and behavioral change strategies.

The conceptual structure of the field, as revealed through Multiple Correspondence Analysis, reflects a stratified but interconnected body of knowledge ranging from abstract theoretical models to applied empirical research, with general constructs like sustainability and behaviour serving as thematic bridges.

This study not only maps the intellectual structure, geographic distribution, and thematic progression of research on psychological approaches to waste management but also identifies critical gaps and future directions. By spotlighting interdisciplinary integration, and evolving themes, this analysis provides a valuable foundation for scholars, and practitioners committed to promoting sustainable behaviour, environmental resilience, and inclusive global research collaboration.

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