Editing Practice

OPINION

Current situation and prevention strategies of paper mills

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ABSTRACT

In recent years, there has been a sharp increase in the retraction of academic papers due to issue of "paper mills". Multiple pieces of evidence indicate that papers produced by paper mills have infiltrated academic papers, posing a huge challenge to academic publishing integrity. This article summarizes the definition and specific manifestations of paper mills, the harm they cause, as well as the preventive and response strategies carried out by stakeholders. In addition, it puts forward suggestions and areas for improvement for the Chinese academic community in preventing paper mill issues. It provides a reference for strengthening the awareness and attention of researchers and journal editors to the problems of paper mills, promoting the implementation of more effective countermeasures, and maintaining research integrity.

Key words: paper mills, academic publishing, research integrity, artificial intelligence

INTRODUCTION

In recent years, issues related to publishing ethics and research misconduct have been on a sharp rise, as evidenced by the surging number of retractions. An article published in Nature on December 12, 2023, showed that in 2023, the number of retracted articles exceeded 10,000, surpassing all previous annual records.[1]

Among the over 10,000 retracted papers in 2023, the majority came from the journals published by Hindawi,[2] a subsidiary of the publisher Wiley. Hindawi officially released an official white paper titled "Addressing the Issue of Large-scale Publishing Manipulation: Hindawi's Journey and Its Implications for Academic Publishing", which explores the issue of large-scale academic publishing manipulation and the impact on Hindawi. In this white paper, Hindawi mentioned some reasons for the retractions: peer review fraud, paper mills, and the sale of authorship of papers. These issues have not only distorted the academic landscape but also posed a serious challenge to the integrity of academic publishing.[3] Research shows that paper mills are estimated to have first emerged possibly as early as 2000, as at least 400,000 papers published between 2000 and 2022 exhibit the characteristics of papers produced by paper mills.[4] In recent years, through the investigations conducted by research integrity experts and integrity detectives, there is conclusive evidence indicating that papers produced by paper mills have infiltrated academic literature.[5,6]

At present, there have been no articles published by editors of Chinese scientific and technological journals that comprehensively review the definition, current situation, coping strategies, and specific suggestions regarding paper mills. Innovatively, this article sorts out and analyzes relevant news, research reports, and policy guidelines disclosed by authoritative management institutions, the media, and publishing research institutions, and summarizes the definition and threats of paper mills, as well as the prevention and coping strategies that have been carried out by various

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stakeholders, including detection methods, international cooperation, policy guidelines, and so on. Finally, some suggestions and improvement directions for preventing paper mills in China's academic community are put forward. This article provides reference significance for enhancing the awareness and attention of researchers and journal editors to the issue of paper mills, promoting the implementation of more effective countermeasures, and maintaining academic integrity and the quality of scientific research.

THE DEFINITION, CURRENT SITUATION AND HAZARDS OF PAPER MILLS

Paper mills, which systematically manipulate the publishing process, have become one of the most prominent research integrity issues in the past two years and belong to large-scale academic misconduct. They are profit oriented, unofficial, and potentially illegal organizations,[7] which aim to systematically manipulate the publishing process to obtain economic benefits by publishing papers. They produce and sell fraudulent manuscripts that appear to be genuine research. They can also infiltrate the management of article submissions to journals for review and sell authorship to researchers after the articles are accepted.

The specific manifestations of paper mills include (1) large-scale batch submissions; (2) false authorship/false papers; (3) review mills; (4) using artificial intelligence (AI) to fabricate manuscripts and manipulate images, *etc.* In reality, the manuscripts produced by operating paper mills may exhibit any one or a combination of the above forms. For example, most of the retractions from Hindawi came from its special issues, which are often managed by guest editors. This arrangement has opened the door for paper mills, enabling them to manipulate editors and reviewers and facilitate the buying and selling of authorship and the publication of false papers. Meanwhile, a new type of improper review behavior, known as the review mills, is emerging.[8] Reviewers' comments are often generic and repeatedly reused template content, disguised as meaningful comments. Since there is no evaluation of the content of the papers being reviewed, it is possible to generate false review reports without the need for a high level of expertise in the subject matter. These reports, apart from repeating affirmations and general questions, do nothing and can be easily applied to papers in different fields such as social sciences, theoretical physics, and biomedicine. A more serious behavior is that some scholars work for paper mills. They volunteer to become guest editors and manipulate the peer review process, enabling the journals to accept the papers produced by paper mills.[9]

As mentioned earlier, the papers produced by the above-mentioned paper mills may be one of the important reasons for large-scale retractions. The problem of retractions has reached a rather serious level in China's academic community. The news team of the Nature magazine used data provided by three private research integrity and analysis companies to show that from 2014 to 2024, nearly 60% of the retracted articles (more than 20,000 of them) had authors affiliated with China. Overall, so far, about 0.3% of articles in China have been retracted three times the global average.[10] The National Health Commission's website announced the investigation and handling results of 14 batches of medical scientific research integrity cases from June 8, 2021, to February 22, 2022.[11] The total number of cases announced accumulated to 321, among which 149 cases involved "paper mill behaviors" such as ghostwriting and agency submission of papers, and the buying and selling of papers and data, accounting for nearly half of the total. This shows that "paper mills" are important drivers of the medical paper trade, providing full process services of ghostwriting and agency submission, and "producing" everything from ordinary papers to papers for top tier journals. The situation in other countries is also not very optimistic. Due to the large scale retractions that occurred in 2023, in May 2024, Wiley announced the suspension of 19 scientific journals under its subsidiary Hindawi. In November 2024, the mega journal Cureus shut down six of its so-called "academic channels" that were alleged to be "paper mills". These channels were originally promoted as low-cost publishing platforms, promising to build the organizations into publishing powerhouses. However, a joint investigation by Science and Retraction Watch found that some paper mills had established their own channels in journals, providing convenience for groups such as foreign doctors seeking residency positions in the United States through seemingly simple publications.[12] As can be seen from the above phenomena, paper mills not only cause a serious waste of research resources, but also cast a heavy shadow over scientific research integrity.

IDENTIFICATION AND PREVENTION STRATEGIES FOR PAPER MILLS

Identifying and preventing paper mills through process optimization cases

Involvement of publication manipulation activities poses many practical challenges for journals and editors. Under various pressures and resource constraints, they have to strive to provide due process for a large number of submissions while dealing with integrity issues in a timely manner.

Some indicators may suggest that a submission is suspected of being related to paper mill behavior, such as duplicate submissions. This is not only a challenge for

editors and reviewers but also a strong indication that paper mills are at work. Editors may be alerted by other editors, reviewers, or text matching software about "simultaneously submitted manuscripts". The flowchart "Concurrent submissions of a manuscript to multiple journals" published by Committee on Publication Ethics (COPE)[13] can help editors identify whether paper mill issues are involved when the phenomenon of submitting one manuscript to multiple journals occurs at the submission stage. The flowchart recommends: comparing the manuscripts to determine the degree of content overlap; suspending the review work during the investigation; if there is evidence indicating systematic redundancy or overlap in the manuscripts, it suggests the existence of repeated dishonest or fraudulent behavior, referring to the COPE guideline, "Systematic manipulation of the publication process".[14]

COPE has recently also released a supplementary version of the guideline above—"Addressing concerns about systematic manipulation of the publication process".[15] The supplementary version is used in conjunction with the previous ones and provide high-level guidance, empowering editors and publishers to consider paper mill cases and make decisions at the batch level (*i.e.*, among a batch of articles identified as having common problem-related associations).

Tools for identifying paper mills

AI-driven tools provide strong support for predicting and dealing with paper mills and maintaining research integrity. Major publishers such as the The International Association of Scientific, Technical & Medical Publishers (STM), Springer and Wiley have launched AI-based solutions one after another, aiming to assist and protect the entire academic publishing ecosystem.

Paper mill checker tool

This is the first service provided by the STM Integrity Hub to publishers. It combines internal and external tools, such as the Papermill Alarm of Clear Skies and the integration of the PubPeer database. It allows integrity staff to upload selected manuscripts to check for various signals, such as duplicate submission signals or an observation list of false domain names or email addresses crowdsourced by integrity experts, improving the accuracy and precision of detecting fraudulent manuscripts.

Duplicate submission checker tool

It started in a pilot form in October 2023 and supports the automatic checking of duplicate submissions across journals, publishers, and editorial systems. Currently, it has connected 12 publishers with more than 150 journals. In 2024, the STM Integrity Hub utilized the technology developed by one of the participating publishers to shift to full-text checking. The success of the Duplicate Submission Checker application (including the automatic content source from the editorial system) has led to the decision to develop this application into an automatic background screening for submitted content. Publishers can choose to screen for various signals. For example, publishers can screen whether the received submissions have duplicate content, check whether the references appear in the Retraction Watch database, and run the content through the Papermill Alarm tool at one time.

Geppetto

Generative Pretrained Transformers (GPT) have made it easier for paper mills to submit a large number of AI-generated manuscripts. Therefore, Springer Nature has developed Geppetto to detect and handle these manuscripts even before they enter the editorial workflow in many cases. The Springer Nature Research Integrity Group (SNRIG) deployed Geppetto in November 2023. Currently, it is pre-screening most of the submissions for books and journals. By identifying potentially problematic submissions at this stage, Geppetto not only protects the academic record (avoiding the need for retractions after publication in many cases) but also relieves the manual work of human editors in the later process.

SnappShot

Recently, a large number of articles have been retracted due to the manipulation and/or duplication of images. Therefore, a solution for quickly and accurately detecting fake images is urgently needed. SnappShot is an AI-driven web solution that can support journal editors and research integrity experts in detecting manipulated images and is directly integrated into the submission system of Springer Nature. The SNRIG cooperated with the AI laboratory of Springer Nature and launched the first version of SnappShot in December 2023, focusing on the duplication of gel and blot (G & B) images in the same article (which is one of the primary issues of image misconduct). Other functions currently under development mainly target issues such as microscope duplication and image plagiarism.

Papermill Detection

A new AI-powered Papermill Detection service is planned by Wiley and being tested in partnership with Sage and IEEE. It operates through the following six tools. (1) Similarity detection of paper mills: Check for the existence of known paper mill markers to identify manuscripts that may come from paper mills. (2) Recognition of problematic phrases: These phrases may suggest that the content has been translated or fabricated by AI-based language models. (3) Detection of abnormal publishing behaviors: Analyze the publishing patterns of paper authors, such as abnormal behaviors like

submitting a large number of manuscripts in a short period or submitting in multiple unrelated fields, so as to identify potentially problematic manuscripts. (4) Identity verification of researchers: Verify whether there are issues like misappropriating others' identities or forging academic experiences among authors to ensure the authenticity and reliability of the submitters. (5) Detection of generative AI content: It can identify potential abuses of generative AI and the creation of false papers, *etc.* (6) Journal scope checker: Analyze the relevance between articles and journals to prevent manuscripts that are off-topic or inconsistent with the positioning of the journal from entering the review process.

Address "paper mills" through international cooperation

The United2Act initiative statement is the outcome of a summit jointly convened by COPE and STM in May 2023. This project involved a number of stakeholders, including researchers, research integrity analysts, publishers, and volunteers, such as the European Research Council, Clarivate, Elsevier, Wiley and Springer Nature. The project elaborated on five areas where action is needed to deal with paper mills in the statement, and each area has a relevant working group in charge.[16] The contents include: strengthening education to raise awareness of the paper mill issue (working group 1); improving post-publication correction work (working group 2); conducting in-depth research on paper mills (working group 3); supporting the development of tools for verifying the identities of authors, editors, and reviewers (working group 4); and ensuring communication among various publishing groups when addressing this issue (working group 5). The "Workshop: How to handle suspected cases of paper mills" held during the COPE Publication Integrity Week 2024 announced the latest progress of the United2Act initiative.[17] The working group 2 of United2Act, which focuses on improving post-publication correction (the group's representatives are from researchers, research integrity sleuths, and contributors from institutions, editors, publishers, and database and analytics providers to address paper mills and the systematic manipulation of scholarly publishing), shared new resources, including an infographic on the challenges of conducting post-publication corrections and an infographic on recommendations for post-publication corrections.[18]

SUGGESTIONS

Paper mills have infiltrated multiple publishing processes, such as trading author identities, influencing or manipulating peer review, and publishing fabricated or plagiarized research (including pictures, data, *etc.*). There is still much room for improvement in the prevention of paper mills in China's academic community. We can simultaneously promote measures in several aspects, such as policy guidance, coordinated cooperation among stakeholders, work processes and AI technology, as well as training and seminars for journal editors, so as to strengthen the prevention of paper mills.

Strengthen the formulation and revision of policies and regulations

The utilization of AI technology by paper mills has brought increasing difficulties in preventing paper mill activities. Currently, the ethical policies newly released by Governance, major relevant scientific research management institutions, publishing associations/organizations, and publishers in China mainly focus on the regulated use of Artificial Intelligence Generated Content (AIGC). For example, the "Guidelines for Responsible Research Conduct (2023)" released by the Ministry of Science and Technology of the People's Republic of China in December 21, 2023;[19] the "Manual of Research Integrity Norms" released by the National Natural Science Foundation of China on December 22, 2023;[20] and the "Reminder on Integrity in the Standardized Use of AI Technology in Scientific Research Activities" released by the Research Ethics Committee of the Chinese Academy of Sciences on September 10, 2024.[21] There is an urgent need to clearly formulate and release relevant policies on how to guard against paper mills in the AI environment. For example, clear policies, norms, and guidance opinions should be formulated regarding the definition and prevention of paper mills, how scientific researchers can exercise self-discipline and refuse to use papers produced by paper mills, and how peer review experts can avoid participating in reviewing papers from paper mills.

Strengthen technological prevention

New work processes should be formulated, as well as AI tools that are being developed/improved and aimed at manuscript review/screening. Signs that submissions may come from paper mills can be more easily detected on a large scale, as they may be similar in layout, experimental methods, and have similar images or graphics. Early warnings can also be triggered through the characteristic recognition of submission email addresses. Therefore, even for journals without mandatory data sharing policies, it is strongly recommended that journals require authors to provide ethical statements and store their original data/images in open or institutional repositories so that the data can be provided upon request at least. Meanwhile, new inspection measures should be introduced in multiple steps of the publishing process, including stricter reviews of peer review.

Strengthen multi-party collaboration

Government management agencies, publishers, scientific research institutions, and funders need to make

collective efforts, as no single party can solve this problem alone. (1) Journals should strive to detect misconduct before publication. (2) After misconduct occurs, journals should correct or withdraw invalid or unreliable data to prevent readers from being misled. (3) Scientific research institutions should investigate allegations of research misconduct and simultaneously introduce corresponding punishment measures. (4) Major seminars and educational activities should be held regularly to ensure that journal editors, guest editors/contributing editors, and peer review experts are kept informed of and can discuss the latest developments and means of paper mills in a timely manner, and to guarantee that they receive relevant training in identifying and dealing with paper mills.

CONCLUSION

This article helps readers accurately understand the concept and operation mode of paper mills, reveals global harm that has been caused and the further potential threats, and summarizes the existing countermeasures, including detection methods, international cooperation, and policy guidelines, *etc.* On the premise of pointing out the deficiencies of the existing countermeasures, it proposes possible paths for preventing paper mills in the future, such as technological upgrades and policy improvements. The author calls on the Chinese scientific community, publishers, academic journals, and scientific research administrators to enhance their awareness of paper mills, deepen cooperation, and take more effective actions with the help of AI technology to prevent paper mills from polluting the academic ecosystem and maintain scientific research integrity.

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