Academic Integrity in Crisis: A Systematic Analysis of Questionable Research Practices

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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***Abstract*—Scientific misconduct has emerged as a growing risk to the academic knowledge base. Questionable research practices such as falsified peer review, predatory conferences, and citation gaming in journal publications have become more prevalent in recent years. As researchers face intense pressure to publish quickly amidst the demand for scholarly findings and literature, the underlying structure of the publishing and research system promotes opportunities for misconduct. The publish-or-perish culture creates incentives for scholars, institutions, and journals to engage in questionable behavior, threatening scientific integrity and public welfare. First, this project synthesizes and classifies the scale of scholarly misconduct in academia during the digital age through a comprehensive taxonomy of questionable research practices. Through a literature review and conversations with library science experts, the types of scientific misconduct were classified in a hierarchical taxonomy. This taxonomy was categorized by perpetrator and type of misconduct. The taxonomy and scope were validated through subject matter expert review. An assessment of the scope of each threat was performed using descriptive statistics and time series quantitative data analysis. This analysis was used to identify trends and inform future work.**

***Index Terms*—Systematic literature review; Ethics; Taxonomy; Information integrity**

I. Introduction

Self-reported surveys indicate that questionable research practices (QRPs) are drastically influencing the quality of publications in virtually every field of science [1]. These practices artificially inflate citations, citation indices, and publication counts [2]. Along with self-reported findings, an increase in QRP engagement appears to stem from institutional pressures evolving from the current organizational structure of the researcher/publisher system. Incentives to engage in QRPs involve reputation-based pressures, publication-based evaluation, and demands to obtain funding sources [3]. With the pressure to publish driving scientific research, researchers are at risk of diverging from standards of scientific integrity.

Many QRPs appear to operate on a systemic level, which often involve prestige and profit-driven research incentives. Systemic QRPs are embedded in the academic ecosystem, providing opportunities for low-quality work to enter the knowledge base and creating dysfunctional incentives for researchers. Institutions may inadvertently drive an individual QRP through systemic QRPs to increase quantitative impact at the expense of research quality. Other external organizations provide services that facilitate QRPs, with commercial entities increasingly engaging in these operations [4]. The Committee on Publication Ethics (COPE) and the International Association of Scientific, Technical, and Medical Publishers (STM) have identified concerns suggesting that the integrity of major publishing entities have been compromised [5]. This report found that fabricated manuscripts accounted for between 2% and 46% of publications submitted to some journals. On the other hand, university-level operations may overlook scientific misconduct, while other publishing entities exploit institutional pressures via mass email solicitation and other marketing tactics [6], [7]. At a macro-level, systemic-based QRPs erode research integrity across publishing and academic networks. QRPs range in ethical boundaries, from minor 'sloppy science' to systemic misconduct. Our dimensional analysis provides a structured approach to examine the complexity of QRPs.

In addition, artificial intelligence (AI) and related tools have become increasingly prevalent in publications. One study estimates that over 60,000 articles published in 2023 contained AI-generated text [8]. In addition, organizations that systemically infiltrate journals and generate articles for profit, known as paper mills, are contaminating the published knowledge base with false research [4].

These QRPs appear to be threatening scientific integrity as they have deeply infiltrated the knowledge base, with up to one in three scientists engaging in some kind of QRP [9]. Our review of this problem revealed that there has been significant research on many individual QRPs, but no comprehensive taxonomy for documenting and understanding them. This project aimed to investigate the scope of QRPs and classify them within a hierarchical taxonomy. Our taxonomy will be used as a framework for raising awareness in academia about questionable research practices. It should provide a thorough examination of all different facets of the problem, allowing researchers to be aware of any and all possible QRPs. It is important to note that the goal of this research is not to stigmatize individual researchers, but to evaluate the pressures that contribute to QRPs and encourage ethical standards in the broader academic community.

In what follows, we present the approach we used to construct and validate the taxonomy. We then discuss the results of this analysis, explore their implications for scientific research, and recommend avenues of future research.

II. Approach / Methodology

The requirements for our project involved the creation of a hierarchical taxonomy. This was created over a systematic process that is documented in the following subsections.

A. Exploratory Phase

Prior to creating the taxonomy, we conducted a literature review and informal interviews to understand the publishing

landscape. Specialists in paper mill detection, open science frameworks, copyright law, and scholarly communications offered broad knowledge of the underlying academic system, as well as specific issues within their expertise. This review revealed a number of individual QRPs with significant research and detection tools compiled around them. It also showed that QRP engagement has primarily been investigated as individual practices and their related systemic level factors [3]. All of these factors influenced the development of the taxonomy.

B. Detection Technologies

During this review, we discovered detection technologies developed to identify QRPs and organizations that work to raise awareness about prominent QRPs. The Papermill Alarm by Clear Skies is a service that detects paper mills [10]. Open Science Framework encourages scientific integrity by offering a space for researchers to document every step of their work for greater accountability [11]. RetractionWatch is a blog that monitors retractions and major news within the academic publishing field, and CrossRef maintains a database of all retractions [12], [13]. The Problematic Paper Screener screens various indicators of questionable research activity, including the use of tortured phrases, unusual rephrasings of established scientific terminology that may suggest AI-modified content [14]. It also maintains records of retraction and a database of flagged papers. COPE offers guidance on how to ethically navigate the publishing sphere, providing case studies on ethically ambiguous situations [15]. There exist several plagiarism detectors and tools leveraging AI to detect falsification, such as Imagetwin.ai and Copyleaks [16], [17]. ERROR (Estimating the Reliability & Robustness of Research) operates on a bounty format where reviewers are financially rewarded for detecting flaws in research [18]. Scholarly Publishing and Academic Resources Coalition (SPARC) is a non-profit organization that advocates for knowledge freedom [19]. The taxonomical bases of these tools also influenced the elements incorporated into the taxonomy.

C. Individual vs Organizational QRPs

QRPs were divided into individual and organizational practices to differentiate between key players and power dynamics. Individual practices encompass those on a researcher level. Examples include data manipulation or artificially inflating citation metrics, known as citation gaming. Organizational practices are those that occur above researchers. These include entities such as predatory journals and conferences. Organizational practices affect researchers by incentivizing QRPs and influencing the research environment. Separating QRPs based on individual and organizational lines reflects both the poor practices researchers are adopting and the questionable organizational ones that enable these behaviors. This division gives the taxonomy greater depth and nuance.

D. Data Sources

During exploratory data analysis, data was pulled from the Scopus database, which included author names, publication counts, and subjects [20].

E. Iterative Validation

Throughout the taxonomy's development, we validated our results through meetings with scholarly communication experts, library science specialists, and RAND Corporation researchers. Within this discussion, we presented the most recent iteration of the taxonomy and received feedback on organization and content. Additionally, every QRP labeled within the taxonomy was validated with a case study found in existing literature or investigative reporting to ensure relevance and applicability. For example, case studies document situations where papers were retracted for a particular QRP, examples pulled from investigative journalism that found fabricated results, or examples of research areas that have received significant scrutiny for QRPs. Finally, we further validated the pertinence and materiality of our results using quantitative methods, such as a time-series analysis, discussed in Section III-B.

III. Results

Fig. 1 provides a high-level overview of the taxonomy generated during this study. Questionable research practices were divided into two categories: individual and organizational. A total of 46 identified individual practices cover researcher-level activity. Furthermore, 35 organizational practices describe higher-level systemic issues. The dotted line in the figure connects individual practices to research institutions. This represents the influence of research institutions on individual researchers: individuals operate within research institutions, and many individual QRPs are motivated by systems that create incentives for questionable behavior.

The second level of the taxonomy labels specific areas into which QRPs are classified. Individual areas encompass citations, lack of transparency, peer review, authorship, intellectual theft, and research manipulation. QRPs within the citation category include coercive citations, adding citations not used in a paper (known as padded references), citations from questionable sources, and citation gaming. Lack of IRB approval and insufficient peer review fall under the lack of transparency category. QRPs associated with peer review are insufficient peer review, falsified peer review, bribery, and theft of reviewed work (republishing already published work). The authorship category includes honorary authorship gifted to individuals who did not significantly contribute, falsified authorship, and exclusion of deserving authors. QRPs within intellectual theft are classified into categories of plagiarism and low value-add contributions, referring to research that does not add meaningful knowledge. Lastly, QRPs associated with research manipulation are divided into results manipulation, including overselling of results, selective reporting, and data manipulation such as data fabrication and selective analysis.

Organizational categories of QRPs were research institutions, funding agencies, publishing, indexes and databases, and conferences. QRPs under research institutions relate to improper management of misconduct allegations and inconsistent IRB standards. Questionable publishing practices, known as predatory publishing, are discussed in Section III-A2. Funding QRPs are divided into private, federal, and agenda-driven funding. This last classification includes conflicts of interest and false expense reporting. QRPs under indexes and databases

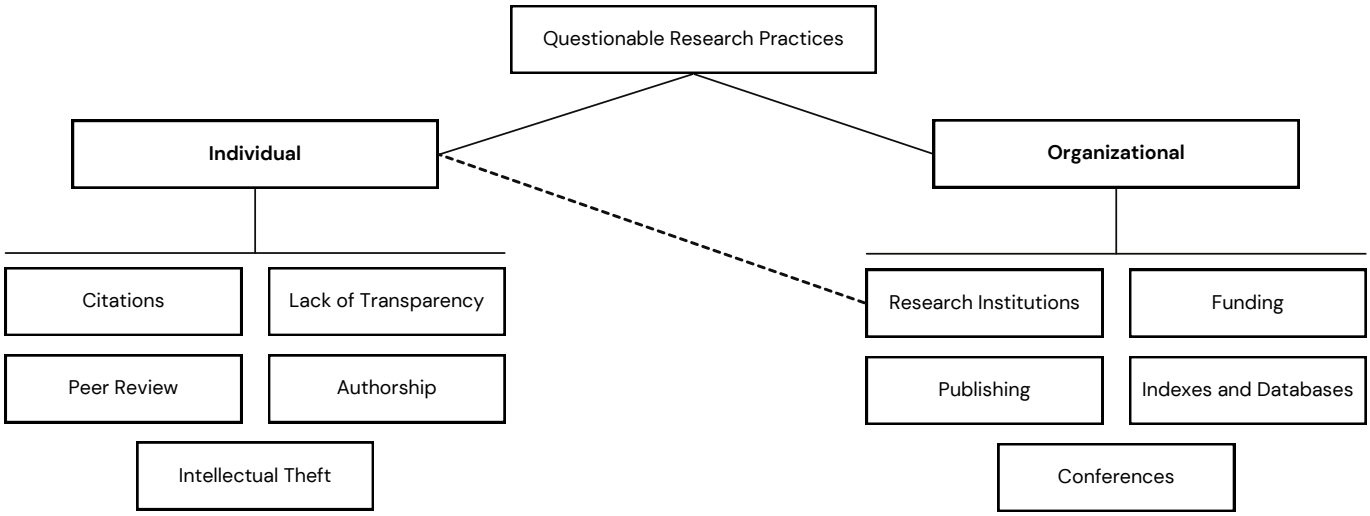

Fig. 1: High-level overview of our taxonomy. Questionable research practices were divided into two categories: individual and organizational. The second level labels specific areas under which QRPs are classified. The dotted line represents the individual practices that have on institutions and vice versa. The full taxonomy [21] further expands on each of these labels, offering 46 individual practices and 35 organizational ones.

encompass situations where illegitimate work is included, insufficient retraction labeling, and bias against non-English work. Predatory conferences are discussed in Section III-A3.

Further taxonomy levels describe specific QRPs. The complete taxonomy is available in [21] along with a dictionary that defines all its elements and each QRP with a case study.

A. Areas of Major Concern

Throughout our review of the literature and conversations with experts, a number of specific problems under third-level areas were identified as being of particular concern. This was due to their increasing prominence or a lack of critical data. All of these problems are discussed below.

1) Peer Review Manipulation: The peer review process, as the first line of defense to academic integrity, is undermined via QRPs relating to manipulated review identities, bias, or ghost-writing activity. Peer review may be undermined through activity involving insufficiency, falsification, and in some cases, outright theft. Emerging operations labeled 'review mills' designate a new systemic threat. In such situations, reviewer reports are misassigned and the output is fabricated, misleading, or tailored towards quick acceptance [22]. Others exploit editorial loopholes to secure biased reviewers, favoring one researcher over another out of convenience [23]. Additionally, the structure of peer review mentorship greys ethical boundaries, and younger researchers with insufficient formal training are at risk of engaging in ghost-writing behavior on behalf of their advisors. Such reviewers contribute to 39% of all peer reviews completed by researchers [24]. Alongside this, global reports point to an increased demand and dependence on peer reviewers to keep up with rapid publication output, which is set to increase dramatically in emerging economies [25]. Peer review integrity is increasingly compromised by editorial loopholes, limited training, and publication pressure.

2) Predatory Publishing: Predatory publishers are defined as illegitimate publishers prioritizing profit and engaging in questionable publishing practices. They are commonly characterized by a lack of peer review and aggressive solicitation of researcher submissions [26]. These journals are often open access and draw profits from article processing charges (APCs) paid by researchers. Within the taxonomy, QRPs associated with predatory publishers are divided between profit-seeking and prestige-seeking behaviors. Profit-seeking behavior includes questionable APC practices, a focus of quantity over quality, and misrepresentation through impersonations of legitimate journals known as hijacked journals or falsified special editions. The taxonomy classifies prestige-seeking QRPs as those that relate to falsifying journal evaluation metrics and questionable editorial board practices. Because predatory journals profit from author fees, some researchers fall victim simply due to a lack of awareness of their existence [27]. These researchers could be junior or academics not properly educated on the publishing industry. Researchers and organizations such as Cabell Publishing Co. and the controversial Beall's List have compiled titles of suspected predatory journals to prevent future researchers from getting deceived [28], [29]. Thus, academics are becoming increasingly aware of predatory publishing tactics, and organizations are developing methods to systematically flag and report the influx of fraudulent journals [30]. However, it is important to note that most publishing misconduct is identified primarily through watchdog-style oversight rather than formalized methods of detection. Despite these measures, predatory publishing remains a lucrative industry. It collected an estimated $393 million in article processing charges in 2021 [31], and the structural incentives of the system continue to drive demand. The open access movement can allow dubious journals to more quickly and easily establish themselves. Additionally, many experts informally interviewed for this project pointed to the publish-or-perish culture of academia as a major driver of demand. Researchers feel the need to publish high numbers of papers to obtain tenure and continued job security. Universities often use metrics such as the h-index and publications per year to judge academic performance [32]. Due

to the lack of peer review, predatory journals provide a near-certain probability of acceptance and a boost to publication metrics. Thus, the evaluation system of academic researchers provides strong incentives to engage with these journals.

3) Predatory Conferences: Predatory conferences are conferences run by for-profit organizations that seek to make money off of researchers rather than create a knowledge-sharing event [33]. Researchers pay fees to attend these conferences only to experience a subpar event, and these events are often correlated with insufficient peer review [34]. Similarly to predatory journals, these conferences often target new or inexperienced academics. They can also be used by cynical researchers to boost citation metrics. Within the taxonomy, QRPs associated with predatory conferences are divided into organizational and misrepresentation categories. The organization category includes insufficient facilitation and peer review, unfair APCs, and acceptance of work outside of conference scope. Misrepresentation refers to false advertising and listing of fake board members. These practices can make the conference seem more legitimate to attract more researchers. Universities and advocacy organizations are raising awareness of this problem and sharing resources to help researchers identify predatory conferences. Furthermore, the Federal Trade Commission sued OMICS Group, a producer of predatory conferences and journals, and was awarded $50.1 million in 2019 [35]. The US government's actions against these conferences show the severity and scale of the issue.

Similarly to predatory journals, the incentives fueling predatory conferences lead to high numbers of predatory conferences. Some now claim that predatory conferences outnumbered legitimate conferences in 2017 [36]. Again, the publish-or-perish mindset often drives researchers to publish in these conferences. Furthermore, the limited number of legitimate conferences can cause researchers to submit their work to predatory ones. Predatory conferences can be difficult to detect and are profitable for companies with an easily copied business model [34]. Using Academy Nature Events as a case study [37], we found that this company offered hundreds of events throughout the year, spanning unrelated disciplines. Many of their conferences reviewed abstracts in four to five days and had an extremely wide scope. The conference website was low-effort and unprofessional. As one possible source of predatory conferences, Academy Nature Events shows the huge number of predatory conferences that just one company can produce.

4) Individual Misconduct: The scope of many individual QRPs remains unknown or unquantifiable. Existing literature of self-reported surveys are limited in understanding the prevalence of these QRPs and the motivations driving them [38]. Incentives for individual researchers to game citations and manipulate research exist within the academic field, but the extent to which these practices occur are unknown. One study found that across 40 biomedical research journals, 3.8% of the papers contained problematic figures, and half of the problematic figures showed signs of deliberate tampering [39]. QRPs can vary widely across disciplines, creating further challenges for establishing scope. Additionally, many individual QRPs have become accepted practice within certain disciplines, such as honorary authorship. Researchers within the marketing discipline are 75% more likely to participate in honorary authorship in journal papers than the average researcher [40]. Current understanding on the scope of QRPs remains largely separated by discipline with little understanding of overall impact. As incentives exist that fuel QRPs, the lack of quantification of the scope of these issues is concerning.

When researching the already existing instances of QRPs that others in this field have observed and named, we utilized various tools like Pubpeer, Problematic Paper Screener, and Retraction Watch to help us identify how certain researchers may be "gaming" the system. One particularly suspicious researcher has shown unsustainable growth in their publications, reflected in an h-index of 130, putting them in the top 1% of authors worldwide. When attempting to understand how this researcher may be effectively manipulating metrics for personal gain, we investigated his research team's website. Here, in their "Build New Optimizer" section, a user can automatically generate a "brand new" optimization algorithm as a simple derivative of existing methods. This would allow other researchers to produce a potential paper and, as a result, a citation back to the original authors. This appears to be, at least in part, responsible for the influx of suspicious "metaheuristic" optimization algorithms that do not appear to make any substantive contribution to the field [41]. By encouraging users to slightly modify an existing algorithm and publish it, the original authors ensure repeated citations without innovation.

B. Quantitative Analyses

In our outscoping phase, we identified several areas of concern within the publishing and research industry such as AI's influence on publication output, citation padding, and paper mills. To align with current trends and sponsor interest, we focused on the influence of AI on academic publication output. To determine whether the advent of AI (marked by the introduction of ChatGPT in November 2022) had an impact on publishing output, we gathered publication output data by year from Scopus and conducted a Welch's two-sample t-test. We compared the year-over-year growth rates from 2011–2022 and 2023–2024. We found no statistically significant effect on annual publication output ($t = -0.85, p = 0.50$). This indicates that the recent increase is consistent with a long-term growth pattern rather than an anomalous spike. This trend can be seen in Fig. 2. This result points to a deeper issue within the publishing industry, which will be discussed in Section IV-A.

Additionally, we explored several other factors that might be influencing publication rates. This included the relationship between the performance of the S&P 500, which is a commonly used benchmark of the stock market, and the percent change of the annual publishing output year over year. We also examined the annual percent change in publishing output for discrepancies across several disciplines such as medical, engineering, biology, and computer science. Our analysis in these areas did not yield any significant results or findings.

IV. Discussion

In this research, we used a literature review and interviews with subject matter experts to develop a hierarchical taxonomy of QRPs. In doing this, we identified peer review manipulation,

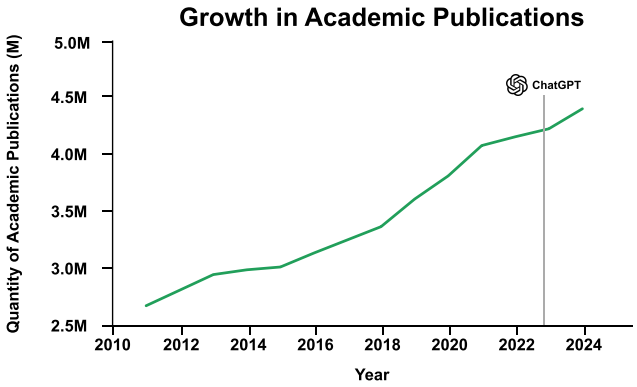

Fig. 2: Academic publishing output from 2011 to 2024 [20].

predatory conferences, predatory publishers, paper mills, and individual misconduct as areas of major concern for the academic world knowledge base. However, we found that specific QRPs are a symptom of the larger problem of an academic system with misaligned incentives. The publish-or-perish mindset found in academia leads researchers to take drastic measures to publish their work and present positive results. Predatory publishers and conferences supply the means for researchers to publish papers with minimal peer review. Paper mills create a supply of authorships that researchers can purchase to increase their publication count. Additionally, the metric-focused tenure system within institutions incentivizes researchers to pursue citation gaming and coerce others for a higher citation count. Researchers also feel pressure to publish work that will garner citations by manipulating data or results to create more compelling papers.

Detecting individual examples of QRPs is helpful in removing harmful materials from the world knowledge base, but is not an effective way to reduce demand for them. Such an approach can also place undue responsibility on researchers for QRPs without acknowledging the forces that cause them to choose ethically ambiguous behavior. Rather, targeting the metrics-focused evaluation system can reduce the pressure on researchers and thus the demand for questionable practices. Predatory publishers and conferences are too numerous for specific investigations of each company, and when one company is caught, many more can easily take its place. As long as demand exists for avenues to publish research quickly and easily, there will be a supply from predatory institutions.

A. Role of AI

AI has a dual and evolving role in the landscape of QRPs. On one hand, generative AI (like Large Language Models) have made it easier than ever to produce convincing text, images, or even entire manuscripts. Unethical actors and paper mills have begun leveraging AI to produce realistic-looking papers at scale [42]. A single operator can generate hundreds of fake papers in a fraction of the time required for an honest scientist to produce one. These AI-generated submissions can be difficult to detect using standard plagiarism detectors since the content is newly synthesized rather than copied. As a result, journals have faced an onslaught of AI-generated submissions that exploit vulnerabilities in the review process.

On the other hand, AI can also be part of the solution. Improved AI-driven detection tools are being developed to identify instances of fake or manipulated research. For example, software now assists in flagging duplicate images in figures, detecting statistical anomalies in data, checking for plagiarism, and catching undisclosed AI usage. However, as generative AI continues to improve, it's uncertain whether detection tools will be able to keep up.

Importantly, AI itself is not necessarily the root cause of QRPs. The demand for ghostwritten or fake papers typically stems from human pressures in academia. In an interview that our team performed with the founder of a papermill detection company, he similarly emphasized the idea that he has not seen a rise in demand in AI-assisted papermill services. This is because the demand is primarily driven by the need for individuals to publish. While AI has accelerated the speed and quality at which paper mills can perform their service, the demand has remained relatively consistent.

B. Changing in Funding Sources

The Trump administration has announced wide-reaching changes to the current research funding structure in the US. Within the first few months of the new administration, the National Institute of Health (NIH) has cut hundreds of active grants relating to diversity, equity, and inclusion and capped indirect costs for universities, hospitals, and research institutes [43], [44]. This may also change the ways researchers pursue funding. Furthermore, limiting the amount of research grants and overhead administrative costs available will likely impact what QRPs are committed by researchers. In particular, researchers may have greater incentive to commit QRPs due greater competition and limited supply of grants. However, a reformed funding structure also has the potential to disincentive QRPs. The administration's policies on research will have a large impact on the system examined within this project, specifically in the United States. The consequences of these policies in relation to QRPs should be analyzed in the future.

C. Scope and Limitations

The scope for this project was limited to investigating ethically ambiguous practices within the academic research community. Practices that were not widespread across the research space were excluded from this taxonomy. This taxonomy encompasses all research disciplines, but prevalence of specific QRPs vary across them. The scope of QRPs may be underrepresented based on the nature of self-reported studies, discussion forums, and known documented cases.

Due to the large scale of this project, some QRPs may be missing from our taxonomy. The taxonomy is created to be a basis for future exploration and will evolve as questionable practices shift with changing technology and incentives. Additionally, we acknowledge this taxonomy is based on literature sources along with investigative work.

D. Detection Tool Technology

We conducted a brief exploratory analysis of potential techniques using publishing output to detect anomalous researchers.

Future research could investigate statistical methods such as: z score, interquartile range, isolation forest, and cumulative sum. Additionally, graph models showed potential that should be investigated further.

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