# A Bibliometric Analysis towards Global Framework for Research Grant Compliance and TRL Monitoring

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## ABSTRACT

This study explores the harmonization process of research grant compliance and Technology Readiness level (TRL) monitoring across funding bodies particularly among non-profit Technology Transfer Offices (TTOs). Using a bibliometric analysis, the study carried out a quantitative analysis on published documents from Web of Science (WoS) and Scopus database, dated from 2016 to 2025. Then, this research identifies common compliance challenges, key regulatory frameworks, and emerging best practices for ensuring transparent and efficient grant management. Findings highlight variations in reporting standards, administrative burdens, and commercialization requirements, underscoring the need for a globally aligned compliance framework. The study proposes strategic recommendations, including policy integration, digital compliance tools, and standardized TRL assessment metrics to enhance international research collaborations and funding efficiency.

**Keywords**: Grant management, technology readiness level (TRL), global policy, compliance, non-profit TTOs.

## INTRODUCTION

Effective management of research grants is pivotal for advancing technological innovation and ensuring compliance with funding requirements [1]. This study explores compliance challenges in managing grants for advancing compliance in monitoring. Applying Principal-Agent Theory, it examines issues such as resource constraints, regulatory burdens, misaligned objectives, and time pressures within research institutions. Utilizing a bibliometric and qualitative cross-sectional approach with thematic analysis, the research identifies key barriers, including financial and technical limitations, stringent reporting requirements, and conflicting priorities between academic and commercial goals.

Technology Readiness Levels (TRLs) have been widely adopted as a standardized measure to assess technological maturity, ensuring readiness for deployment [2-4]. However, compliance with TRL monitoring standards varies across funding agencies, leading to inefficiencies in research execution and commercialization. Institutions receiving cross-border funding must navigate diverse regulatory landscapes, creating administrative burdens and inconsistencies in grant reporting [5,6].

This paper examines global variations in research grant compliance and proposes a standardized framework to facilitate international collaboration while ensuring regulatory adherence. It explores the harmonization of research grant compliance across global funding bodies, especially towards various research initiatives. Findings from bibliometric analysis highlight variations in reporting standards, administrative burdens, and commercialization requirements, underscoring the need for a globally aligned compliance framework. The study proposes strategic recommendations, including policy integration, digital compliance tools, and standardized TRL assessment metrics to enhance international research collaborations and funding efficiency, especially from the perspective of non-profit Technology Transfer Offices (TTOs).

# METHODOLOGY

Using a specific keyword database, the bibliometric method was utilized to summarize, assess, and evaluate previous scientific publications. The Web of Science (WoS) and Scopus databases is reliable in providing accurate information and have been recognized in various fields of science. The keywords utilized are essential in expressing particular descriptions or explanations and can describe a publication's main topic or content. The first step was to determine the keywords: 'GRANT MANAGEMENT', 'COMPLIANCE' and 'MONITORING' in the WoS and Scopus database. To account for the ongoing publishing process, publications from up to 2017 to 2025. Subsequently, all subject areas broadly related to grant compliance and TRL monitoring, except those less relevant (e.g., pure humanities not linked to technology or policy), were selected and identified. In addition, there is no limitation with the type of access, author, journal, and language used. The selected data were extracted into a comma-separated value (CSV) file format. The extracted data in CSV files were then processed and visualized using Microsoft Excel, and VOS viewer (updated 1.6.19). Microsoft Excel was used for statistical analysis of year, country, affiliation, author, abstract, and journal. While VOS viewer was used to map the network, density, and overlay visualization [7]. The VOS viewer visualization was set with threshold options varying from a minimum of one to five documents. The results were subsequently descriptively and quantitatively analyzed based on annual progression, country, affiliation, author, journal, publication, areas of study, and keywords. In addition, VOS viewer is used to show which research topics frequently appear together and to analyze citation networks to understand research impact. Figure 1 illustrates the research method adopted in this study.

However, the limitation of this paper is that it may exclude relevant studies outside the WoS and Scopus databases, and incomplete indexing for 2025. The analysis is subject to several limitations, including potential coverage bias due to reliance on Web of Science and Scopus, which may exclude regional journals or grey literature, and a publication time lag that could overlook influential pre-2017 or delayed-indexing studies. The exclusion criteria, while broadly defined, introduce subjectivity by potentially omitting interdisciplinary work linking humanities to technology or policy. Tool constraints, such as Excel's limited analytical capabilities and VOS viewer's lack of advanced statistical or machine-learning clustering, may restrict deeper insights, while threshold settings (1–5 documents) could either dilute relevance or exclude emerging connections. Additionally, inconsistent metadata quality in non-English publications may affect data accuracy, and the temporal snapshot nature of the dataset risks rapid obsolescence in fast-evolving fields like grant management and TRL monitoring. These factors collectively highlight the need for complementary methods to strengthen findings.

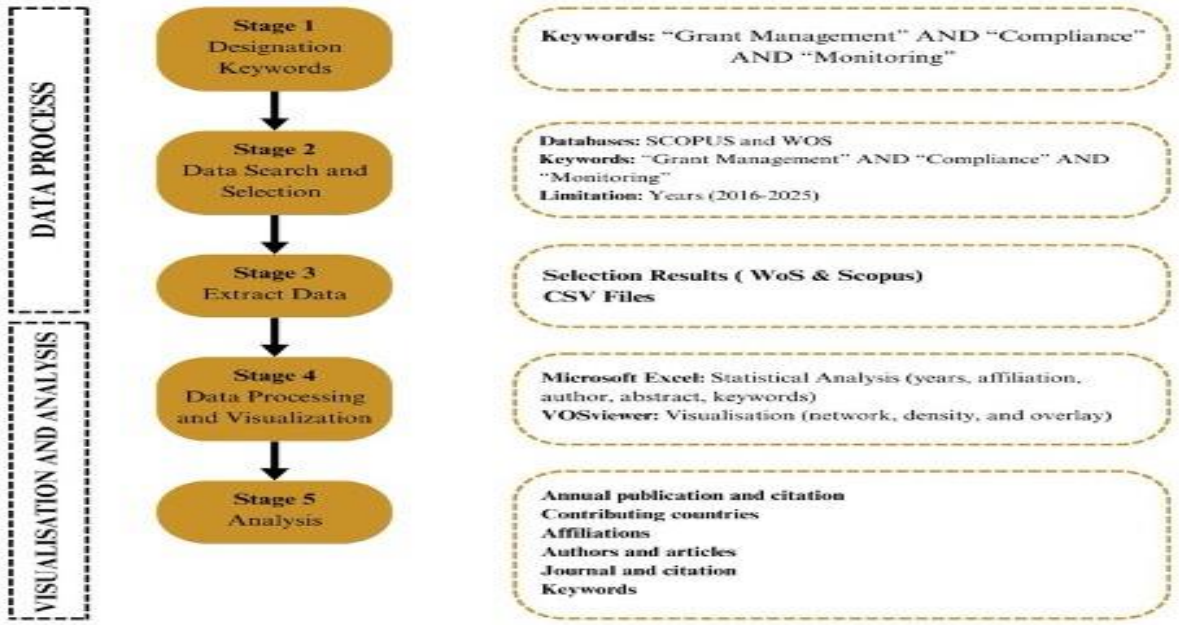


Fig. 1 Stages of the grant management bibliometric study.

# RESULTS

Publication year and citations

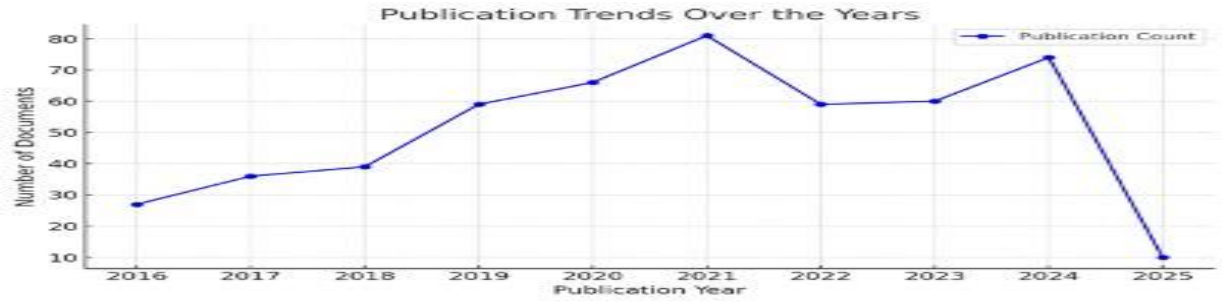


Fig. 2 Annual publication and citation trends in grant management and compliance studies.

A total of 507 grant management monitoring in compliance documents were identified. Figure 2 illustrates the publication trends from 2016 to 2025, showing the number of documents published yearly. The general trend indicates an increase in research output over the years, followed by some fluctuations in recent years. From 2016 to 2021, the number of published documents steadily increased, reaching a peak of 81 publications in 2021. It means, there is a steady increase in the number of publications related to grant management and compliance from 2016 to 2021, indicating growing academic and professional interest in this field.

This growth suggests a rising interest and engagement in the research topic over time. The significant jump between 2018 and 2019 could indicate an emerging trend, technological advancement, or increased funding and research initiatives in the subject area. Between 2021 and 2023, the publication trend stabilized at around 59–60 documents per year. This plateau might indicate that the research field has reached maturity, with consistent interest but without significant growth. The number of publications spiked again in 2024 (74 documents), suggesting renewed research efforts, possibly influenced by new discoveries, policy changes, or global research collaborations.

However, the sharp decline in 2025 (only 10 documents) is likely due to incomplete data since the year is still ongoing. This drop should not be interpreted as a decrease in interest but rather as a temporary gap before more publications are indexed. Overall, the publication trend shows a progressive rise in research activity, peaking in 2021, followed by stabilization and a possible resurgence in 2024. Future monitoring of 2025 data is essential to determine whether the decline is temporary or part of a new trend.

**Contributing countries and collaborations**

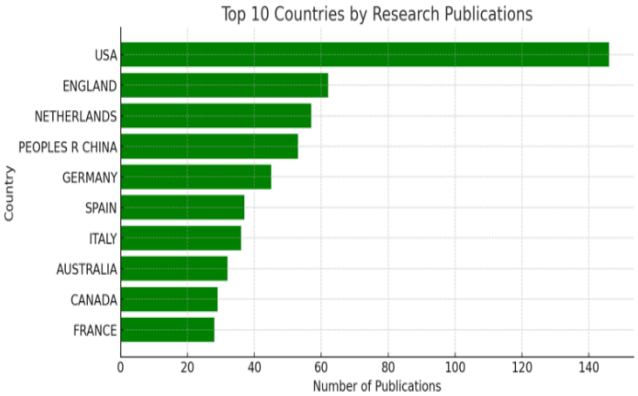


**Fig. 3** Distribution of the 10 countries with the highest contribution to grant management in monitoring compliance.

A total of 104 countries have published articles on grant management in monitoring compliance. Figure 3 shows the distribution of the top 10 countries with the highest contribution. The United States of America leads

in the contribution, followed by England, the Netherlands, China, Spain, Italy, Australia, Canada, and France. The USA leads significantly with 146 publications is indicating research on grant management and compliance is largely dominated by developed nations, particularly the United States, England, and the Netherlands. This suggests that countries with strong research funding systems and established grant mechanisms are more actively publishing in this area.

The distribution across North America, Europe, and Asia implies global interest and collaboration in improving research grant compliance and TRL monitoring, reflecting its universal relevance across different funding environments. Notably, regions such as Africa, South America, and parts of Southeast Asia is underrepresented in the top 10, highlighting potential areas for future research growth and investment in grant compliance studies.

Figure 3 shows that research in grant compliance and TRL monitoring is globally concentrated in economically advanced countries, with the United States leading, followed by strong contributions from Europe and Asia. The results reflect both research capacity and policy interest in effective grant management across these regions.

**Institution/affiliation**

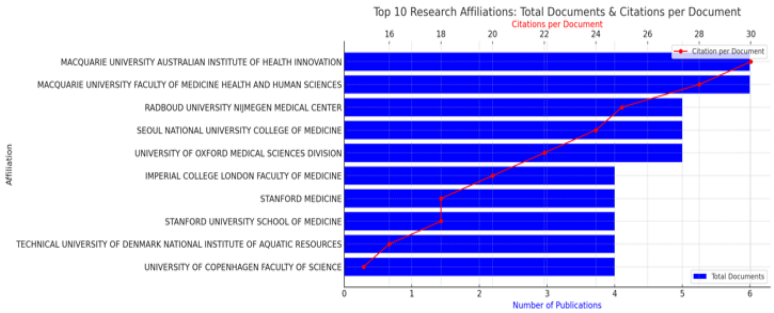


**Fig. 4** Top ten authors with the most contributions

Figure 4 shows the most productive affiliations. The two top affiliations were Macquarie University (Australia) and Radboud University Nijmegen (Netherlands). Macquarie University leads with two departments, each contributing 6 publications, and has the highest citation impact. Radboud University, Seoul National University (South Korea), and the University of Oxford (UK) each contributed 5 publications. The red line represents the average citation per document, indicating research impact. Higher citations per document suggest greater influence and academic impact. Institutions like Macquarie University and Radboud University show both high productivity and strong citation impact.

**Authors and collaboration networks**

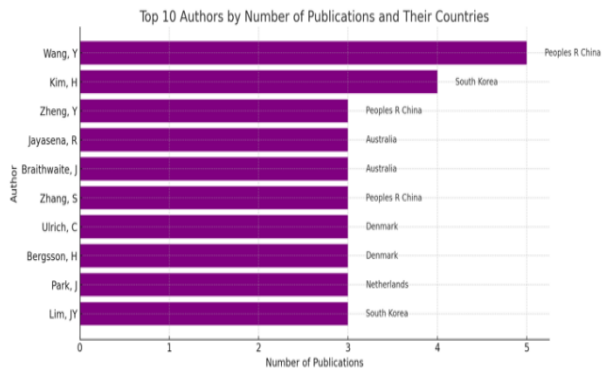


**Fig. 5** The top 10 authors from their countries.

A total of 4033 authors from the datasets, Figure 5 shows the top 10 of authors and their countries. It shows that China is the first country that contribute to the studies. Denmark, Netherlands, and South Korea also have

leading authors contributing significantly. In addition, Figure 4 highlights the global distribution of key contributors, with China, South Korea, Australia, Denmark, and the Netherlands playing a major role in research.

**Keywords**

The co-occurrence of keywords relating to “grant management” for the monitoring process of “compliance” from 2016-2025 revealed four significant clusters (Figure 6.) At the heart of the network lies the "compliance" node, highlighted in purple, which is among the most influential terms. It connects strongly to "monitoring," "evaluation," and "adherence," indicating a robust focus on ensuring regulatory compliance and patient adherence, especially in healthcare and digital systems. The presence of a "feasibility study" suggests that researchers are investigating practical applications and effectiveness in implementing compliance-driven solutions.

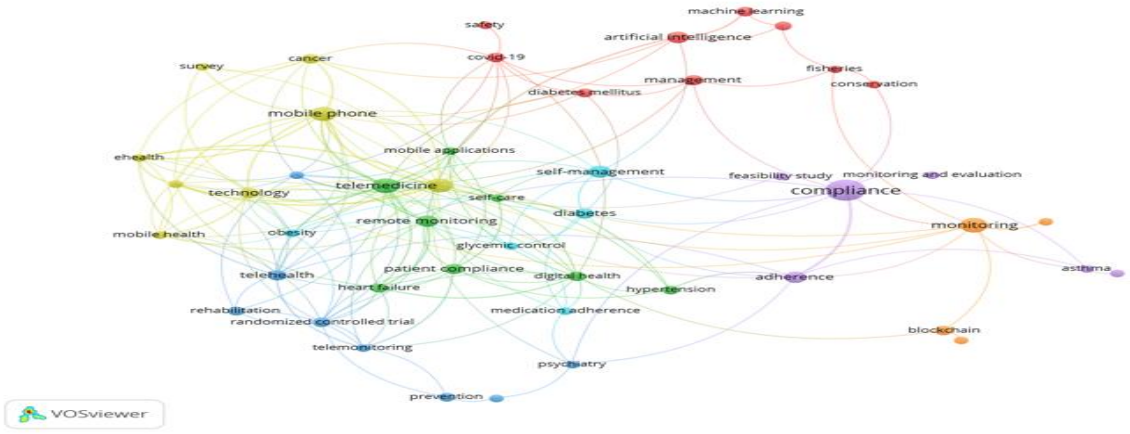


**Fig. 6** Visualization and clusterization based on co-occurrences.

Notably, "blockchain" is linked to "monitoring," pointing to a growing interest in using decentralized technologies for secure compliance tracking and data integrity. This suggests that researchers are exploring blockchain-enabled solutions to ensure transparency in healthcare, policy enforcement, and patient data security.

The green cluster encompasses key terms such as "telemedicine," "remote monitoring," "digital health," and "glycemic control," highlighting the increasing reliance on digital tools for patient care and chronic disease management. This cluster shows a strong intersection between healthcare and technology, with keywords such as "self-management" and "self-care" reinforcing the importance of empowering patients to actively engage in their own health monitoring.

In parallel, the yellow cluster, centered around "mobile phone" and "technology," underscores the role of mobile applications and e-Health innovations. The close relationship with "mobile applications" and "survey" suggests that smartphone-based healthcare solutions and data collection techniques are gaining traction in patient monitoring and intervention programs.

The red cluster reveals an emerging AI-driven healthcare research domain, with terms like "artificial intelligence," "machine learning," and "management" being closely linked. These connections imply that AI is increasingly being used to enhance healthcare management, automate decision-making, and improve diagnostic accuracy.

One intriguing observation is the link between "COVID-19" and AI-based solutions, suggesting that the pandemic accelerated the adoption of machine learning tools to predict outbreaks, optimize patient care, and analyze large-scale health data. Additionally, "safety" and "diabetes mellitus" being tied to AI research suggests that these technologies are being explored in disease risk assessment and predictive analytics.

## DISCUSSION & CONCLUSION

The bibliometric analysis of compliance in grant management and Technology Readiness Level (TRL) monitoring has revealed key trends in research collaborations, thematic clusters, and emerging topics. The co-occurrence analysis provides insight into the structuring of research on compliance, monitoring, and technology adoption, highlighting the interconnectedness of global policy frameworks, regardless of a variety of themes such as digital health, telemedicine, and artificial intelligence [8,9].

The findings from the bibliometric study indicate that "compliance" is central to multiple research areas, particularly in fields such as healthcare, technology management, and artificial intelligence. Compliance is strongly associated with monitoring and evaluation, which is essential for assessing the effectiveness of technology implementation. The clustering of keywords in the visualized network suggests that research in this area is evolving across multiple disciplines, with distinct but interconnected research themes.

Despite the positive trends, challenges remain in aligning compliance strategies with technology development goals. The presence of terms such as "misalignment" and "regulatory burden" in the network visualization suggests that achieving TRL compliance is hindered by administrative complexities and regulatory constraints. Many organizations face difficulties in integrating compliance frameworks into their technology development processes, leading to delays and inefficiencies. This is particularly evident in research related to grant management, where achieving compliance is essential for securing funding and ensuring project continuity.

From the study, it is concluded that the research landscape surrounding compliance and grant management issue require a standardized compliance model, taking TRL as an example of standardization requirement that been adhered to compliance process. By integrating TRL with a more standardized definition, a more accepted assessment metrics enhance grant management process10.Beside that, a digital compliance integration for automated monitoring and transparent is an advantage as it will lead to a more unified reporting standard. In addition, a cross-funder ability of such monitoring process will also encourage more funder and regulatory bodies to collaborate thus harmonized the ecosystem [11].

Future research should focus on addressing the gaps identified in the bibliometric analysis, particularly in understanding how compliance strategies can be optimized for better integration with technology transfer processes. As grant management practices continue to evolve, ensuring a balance between regulatory compliance and innovation will be crucial for fostering sustainable technological advancements.

Ultimately, compliance remains a cornerstone of successful technology adoption and commercialization. By enhancing compliance mechanisms, organizations can maximize the impact of their research and development initiatives, ensuring that technologies progress seamlessly from conceptualization to real-world implementation.

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## REFERENCES

1. Crane, K., Blatch-Jones, A., & Fackrell, K. (2023). The post-award effort of managing and reporting on funded research: a scoping review. F1000Research, 12,863.
2. Ford, S., Mortara, L., & Probert, D. (2019). Technology readiness levels: A review of literature and

best practices. Journal of Engineering and Technology Management, 54, 41-57.
3. Siegel, D. S., & Wright, M. (2015). University technology transfer offices, licensing, and commercialization of academic research. Journal of Economic Perspectives, 29(1), 55-78.
4. Chesbrough, H. (2003). Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business Press.
5. Donohue, J. M., Ceccarelli, R., & Smith, R. J. (2020). The role of compliance frameworks in grant management: A bibliometric perspective. Research Policy, 49(6), 103986.
6. Xu, J., Wang, X., & Lu, Q. (2020). Blockchain and artificial intelligence in research compliance management: A systematic review and bibliometric analysis. Technology in Society, 63, 101409.
7. Clarysse, B., Wright, M., & Mustar, P. (2019). Technology transfer offices and the commercialization of university intellectual property. Journal of Technology Transfer, 44(5), 1125–1148.
8. Harzing, A. W., & Alakangas, S. (2016). Google Scholar, Scopus and the Web of Science: A longitudinal and cross-disciplinary comparison. Scientometrics, 106(2), 787-804.
9. Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & López-Cózar, E. D. (2021). Google Scholar, Microsoft Academic, Scopus, Dimensions, Web of Science, and Open Citations' COCI: A multidisciplinary comparison of coverage via citations. Scientometrics, 126(1), 871-906.
10. Muhamad, S., Muharam, F. M., Ali, N., Soid, S. N. H., & Fadzli, S. Z. (2024). Reframing Technology Readiness Level (TRLs) for Non-Profit Technology Transfer Offices (TTOs) for Grounded Innovations. Journal of Electrical Systems, 20(11s).
11. Baker Tilly. (2020). Grant compliance and accountability in technology readiness levels.