Postprint of a Study on the Implementation Status, Influencing Factors, and Promotion Strategies of the Measures for the Management of Scientific Data

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Date: 2023-04-01T16:02:44+00:00

Abstract

[Purpose/Significance] This study investigates relevant issues concerning research outcomes, implementation status, and influencing factors related to the implementation since the promulgation of the Measures for the Management of Scientific Data, aiming to provide references for its further implementation. [Method/Process] First, we systematically review relevant research outcomes on the Measures for the Management of Scientific Data. Then, we investigate the implementation status among stakeholder institutions in scientific data management. Next, we analyze influencing factors from both positive and negative perspectives. Finally, we propose several promotion strategies for implementation. [Results/Conclusions] The study reveals that current implementation is primarily driven by functional departments at various government levels, with the overall status remaining suboptimal. Positive factors facilitating implementation include the increasing prominence of data value, improved data infrastructure, high-level national priority, evident government promotion, and abundant relevant research. Negative factors impeding implementation encompass weak stakeholder awareness, managerial absence in relevant institutions, ambiguous positioning of implementation plans, lack of supervision and incentive mechanisms, and insufficient practical research. Implementation can be advanced through enhancing awareness and strengthening practical research, promoting institutional and mechanism construction, and intensifying cooperation among stakeholders.

Full Text

Research on the Implementation Status, Influencing Factors, and Promotion Strategies of the *Scientific Data Management Measures*

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Abstract: *[Purpose/Significance]* This paper discusses the related research, implementation status, and influencing factors of the *Scientific Data Management Measures* since its promulgation, in order to provide reference for the further implementation of the Measures. *[Method/Process]* Firstly, the paper systematically reviews relevant research on the *Scientific Data Management Measures*. Secondly, it investigates the implementation status from the perspective of scientific data stakeholder institutions. Thirdly, it analyzes both positive and negative factors influencing the implementation of the Measures. Finally, the paper proposes several strategies to promote the implementation of the *Scientific Data Management Measures*. *[Result/Conclusion]* The study finds that the current implementation of the Measures is primarily driven by government functional departments at all levels, yet the overall implementation status remains unsatisfactory. Positive factors promoting implementation include the increasing prominence of data value, improved data infrastructure, high-level national attention, clear government promotion, and abundant related research. Negative factors hindering implementation include weak stakeholder awareness, institutional management failures, ambiguous implementation planning, lack of supervision and incentive mechanisms, and insufficient practical research. The implementation of the Measures can be promoted by enhancing awareness and strengthening practical research, advancing institutional and mechanism construction, and improving cooperation intensity among stakeholders.

Keywords: *Scientific Data Management Measures*; stakeholders; implementation; scientific data; data management
Classification Number: G250
DOI: 10.13266/j.issn.0252-3116.2021.02.007

Scientific data has become a fundamental and strategic resource supporting national scientific and technological innovation as well as economic and social development. Since the 1990s, relevant departments in China have attached great importance to scientific data research and practice, achieving significant progress. However, prominent contradictions and weak links remain in related work. In response to these issues, the Party Central Committee and the State Council have made timely deployments: in December 2016, “strengthening and

standardizing scientific data management measures" was included in the 2017 work priorities of the Central Leading Group for Comprehensively Deepening Reform; in March 2017, the Ministry of Science and Technology, together with relevant departments, initiated the formulation of the *Scientific Data Management Measures* (hereinafter referred to as the "Measures"). In January 2018, the Measures were reviewed and approved by the Central Leading Group for Comprehensively Deepening Reform, and on March 17, 2018, they were officially issued by the General Office of the State Council. The promulgation of the Measures will further strengthen and standardize scientific data management in China, ensure scientific data security, improve open sharing levels, and better support national scientific and technological innovation, economic and social development, and national security. More than two years have passed since the Measures were issued. The status of their publicity, implementation, and enforcement reflects not only the effectiveness of national-level institutional norms but also directly affects the progress of scientific data management in China. Therefore, tracking, understanding, and studying the implementation status since the Measures' promulgation, analyzing its influencing factors, and proposing promotion strategies are of great significance.

1 Brief Review of Related Research on the Measures

Using "Scientific Data Management Measures" as the search term, a subject search was conducted on CNKI (search date: June 5, 2020). Current research on the Measures primarily focuses on significance interpretation and content analysis.

1.1 Interpretation of the Measures' Significance

As the first national-level regulation in China's scientific data field, the Measures hold milestone value and significance for scientific data stakeholders and practical data management work. Consequently, discussing their significance has become an unavoidable topic for researchers. The promulgation of the Measures has ushered China into an important historical opportunity period for the development of scientific big data, with each proposed measure addressing current deficiencies in China's scientific data management. The Measures provide guidance on scientific data management principles, institutional norms, intellectual property rights, and incentive mechanisms, establishing an action program for scientific data management practice. They highlight the state's high attention to standardized scientific data management and scientific and technological innovation capacity building, help promote deep integration of innovation and industrial chains, and are significant for improving China's scientific data management capabilities and levels, thereby maximizing the output benefits of national financial investment in related fields. The Measures also provide strong support and guarantee for government decision-making, national security, national defense construction, and scientific research. Therefore, we should seize this excellent opportunity to enhance the concept and level of scientific data

open sharing, and research scientific data standards and sharing norms suitable for various fields from the perspectives of openness, standardization, and security.

1.2 Content Interpretation of the Measures

Interpretation of the policy text's specific content can help scientific data stakeholders deeply comprehend the Measures' spirit and provide reference for their effective implementation. The Measures stipulate a mandatory scientific data submission system, specify concrete measures to improve scientific data utilization rates, and establish a data disaster backup mechanism. These systems and measures help balance the contradiction between "utilization" and "confidentiality" of scientific data. The Measures also clarify three principles: "openness as the norm, non-openness as the exception" for scientific data, "consistency of rights and responsibilities" for scientific data sharing, and "combining public welfare with marketization" for scientific data development and utilization. They have formed a scientific data management system with the data lifecycle as the warp and responsible stakeholders as the weft. Some researchers have interpreted and analyzed the Measures' content from different perspectives, such as institutional mechanisms and security measures, the scientific data lifecycle, and quantitative analysis of the Measures' textual wording and themes. Additionally, Chu Wenjing et al. constructed a university scientific data management standard process based on the full scientific data lifecycle according to the Measures' content. Gao Yuwei et al. conducted a comparative analysis of 11 issued implementation rules, concluding that these rules emphasize policy coordination, highlight platform applications, stress confidentiality and security, and value assessment and evaluation.

1.3 Other Research on the Measures

As time has passed since the Measures' promulgation and related research has continuously enriched, other research beyond significance and content interpretation has emerged. First, **industry application of the Measures**: Chu Wenjing et al. constructed a Chinese scientific data alliance management model from three aspects—alliance architecture construction, virtual working group establishment, and management mechanism establishment—based on the scientific data management process proposed in the Measures. Yan Peng explored issues concerning archives departments' participation in scientific data management from a stakeholder perspective and proposed pathways for their involvement. Second, **strategies for improving implementation**: Wang Jina argued that the Measures failed to clarify ownership of scientific data and the management of scientific data generated by non-government funding. Hu Lianglin et al. comprehensively summarized the main achievements of the Chinese Academy of Sciences in scientific data standards and norms, hoping to provide reference and solutions for implementing the Measures. Third, **policy agenda analysis**: Bai Rui et al. analyzed the Measures' policy agenda from the perspectives of

problem streams, policy streams, and political streams in the Chinese context, arguing that the national big data strategy opened a "policy window" for the convergence of the three streams, ultimately bringing the Measures into the policy agenda and into implementation.

1.4 Current Research Review

Overall, current research on the Measures primarily focuses on significance interpretation and content analysis, with insufficient attention paid to implementation status, influencing factors, and implementation effectiveness evaluation. The promulgation of the Measures has guided the formulation of implementation rules in some provinces and cities, indicating that the Measures have begun preliminary implementation. However, this is only the beginning, and further research and exploration are needed.

2 Investigation of Preliminary Implementation Status

Since the Measures' promulgation, multiple mainstream media outlets have published special reports or reprinted commentaries, experts and scholars have been interviewed by the media to answer related questions, and researchers have written articles and offered suggestions, generating strong responses. Based on stakeholder theory, the Measures clarify the responsibilities of different responsible entities, designating the State Council's science and technology administrative department, relevant State Council departments and provincial people's government departments, research institutes and higher education institutions and enterprises, and scientific data centers as the leading unit, competent departments, legal entities, and important carriers of scientific data management, respectively. To clarify the implementation status of various stakeholders two years after the Measures' promulgation, this study employed web-based investigation from June 8, 2020, to July 7, 2020, examining implementation from the perspective of the four types of responsible entities stipulated in the Measures. The investigation found that science and technology management departments, local governments, research institutes, higher education institutions, and data centers have all taken action.

2.1 Implementation Status of Leading Units

Article 7 of the Measures states that "the State Council's science and technology administrative department is responsible for the macro-management and comprehensive coordination of national scientific data." Upon the Measures' release, the Ministry of Science and Technology immediately held a press briefing to interpret the Measures' content from multiple aspects. To further standardize the management of national science and technology resource sharing service platforms and improve the science and technology resource sharing service system, on June 5, 2019, the Ministry of Science and Technology and the Ministry of Finance jointly issued the *List of Optimized and Adjusted National Science*

and Technology Resource Sharing Service Platforms, optimizing and adjusting the original platforms. On February 17, 2020, the Ministry of Science and Technology issued the *Notice on Several Measures for Breaking the "Paper-Only" Unhealthy Orientation in Science and Technology Evaluation (Trial)*, explicitly incorporating scientific data into assessment criteria. In addition to the Ministry of Science and Technology's actions, national leadership has continuously emphasized data management work. On April 9, 2020, the *Opinions of the CPC Central Committee and the State Council on Building a More Perfect System and Mechanism for Market-oriented Allocation of Factors of Production* was officially released, requiring accelerated cultivation of the data factor market and including data as a factor of production for the first time. The document required advancing government data openness and sharing, enhancing the value of social data resources, and strengthening data resource integration and security protection. The issuance of these notices and opinions undoubtedly provides great incentive for scientific data stakeholders and is conducive to the implementation of the Measures, reflecting the leading department's attention to the Measures' implementation.

2.2 Implementation Status of Competent Departments

Article 8 of the Measures designates relevant State Council departments and provincial people's government departments as competent departments for scientific data management. Following the Measures' promulgation, in addition to promotion and implementation by provincial government departments, local people's governments at all levels republished and reported the full text on their official websites and required relevant units to actively implement the Measures. To date, government departments have conducted preliminary implementation, with multiple provinces and cities issuing implementation rules or provincial-level "Measures." The specific details are shown in .

In addition to issuing implementation rules, some provinces and cities have successively introduced supporting policies and regulations, even incorporating scientific data management effectiveness into performance assessment scopes. These policies and regulations will effectively promote effective scientific data management at all levels. The investigation shows that provincial-level implementation rules began to be issued within half a year after the Measures' promulgation, demonstrating the high attention and strong execution of local government institutions toward the Measures, creating a good start and laying a solid foundation for further implementation.

2.3 Implementation Status of Legal Entities

Article 9 of the Measures states that "relevant research institutes, higher education institutions, and enterprises as legal entities are the responsible entities for scientific data management." Various legal entities have also taken proactive actions in practice.

(1) Research Institutes: The Chinese Academy of Sciences (CAS) attaches great importance to the Measures, requiring active cooperation. On one hand, it actively coordinates with the Ministry of Science and Technology to advance the construction of national scientific data centers in various disciplines. In 2019, CAS launched the construction of an integrated scientific data center network with a "general center—disciplinary center—institute-level center" three-tier structure, supported by security, operation, and evaluation systems. The scientific data center system has been initially formed. On the other hand, CAS actively formulates its own scientific data management measures. In February 2019, the *CAS Scientific Data Management and Open Sharing Measures (Trial)* was issued. Subsequently, the Institute of Oceanology and the Northeast Institute of Geography and Agroecology formulated their own scientific data management and open sharing measures based on or referring to the national Measures and the CAS measures. In July 2019, the Chinese Academy of Agricultural Sciences issued the *Agricultural Scientific Data Management and Open Sharing Measures of CAAS*, representing a concrete manifestation of implementing the national Measures' general requirements.

(2) Academic Societies: On July 22, 2019, the China Editology Society of Science Periodicals issued the *Statement on Promoting Academic Integrity and Ethical Norms in Academic Publishing*, requiring scientific and technical workers to comply with journals' data sharing policies and conduct data sharing. Editorial departments of journals such as *Library and Information Service* (February 2020), *Chinese Journal of Scientific and Technical Periodicals* (February 2020), *Journal of Documentation and Data* (March 2020), and *Think Tank: Theory & Practice* (March 2020) successively issued "publishing ethics statements," requiring authors to "attach great importance to the standardization of research data and management, comply with the Measures, and strengthen data management and open sharing." Some academic conferences organized by institutions also included agenda items interpreting the Measures, such as those held by the Wood Specimen Museum of the Chinese Academy of Forestry and the Institute of High Energy Physics of CAS.

(3) Higher Education Institutions: Many universities republished the State Council's announcement on their homepages, calling on all faculty and students to study and comprehend it. Individual universities also formulated relevant measures, such as Chongqing Youth Vocational and Technical College, which formulated the *Chongqing Youth Vocational and Technical College Scientific Data Management Measures (Trial)* based on the Measures and the *Measures for Preventing and Dealing with Academic Misconduct in Higher Education Institutions*, and publicly issued it on February 27, 2019.

The investigation shows that although some legal entities have taken action on the Measures, overall implementation remains unsatisfactory compared with competent departments' requirements. During the investigation, many universities were found to have formulated data management measures, such as the *Northwestern Polytechnical University Data Resource Management Measures*

(Trial) (December 3, 2019), *Wuhan University Data Management Measures (Trial)* (October 31, 2016), and *Dalian University of Technology Informatization Data Resource Management Measures (Revised)* (July 4, 2019). However, these "measures" primarily target transactional data such as business and management data of the university, rather than scientific data.

2.4 Implementation Status of Data Centers

Article 10 of the Measures states that "scientific data centers are important carriers for promoting scientific data open sharing." Following the Measures' promulgation, some scientific data centers/platforms responded actively: the Guiyang Big Data Exchange stated it would jointly release scientific data value according to the Measures; the Big Data Center for Life and Health of the Beijing Institute of Genomics, Chinese Academy of Sciences, carried out a series of works in accordance with the Measures' requirements; the National Population Health Science Data Center explicitly requires classification, annotation, organization, and security storage throughout the entire lifecycle of submitted population health scientific data based on the Measures and relevant policies and technical regulations, providing data sharing services at different levels and with different permissions for the industry and society, indicating data sources, and complying with intellectual property-related regulations and usage conditions attached during data submission. The public general-purpose "Science Data Bank" constructed by the Computer Network Information Center of the Chinese Academy of Sciences has also undergone system upgrades, with its version 2.0 officially launched in August 2019, providing a platform for scientific data producers to submit, store, and manage scientific data in accordance with the Measures' requirements. Although some scientific data centers have taken action, continued efforts are needed to promote implementation.

3 Analysis of Influencing Factors on Implementation

The investigation shows that the Measures, issued only two years ago, have been implemented to some extent with government departments taking the lead. However, overall implementation is not ideal, which is largely related to the short time since the Measures' promulgation. To further promote the Measures' implementation and clarify opportunities and obstacles, it is necessary to analyze the influencing factors.

3.1 Positive Factors Influencing Implementation

As the utility and value of scientific data become increasingly prominent, scientific data's role and positioning as a fundamental, strategic, and critical resource have become consensus among all parties. China has always attached importance to scientific data management, particularly in recent years, issuing a series of policies and norms and increasing investment in data infrastructure construction, laying a solid foundation for the sound development of scientific data

management and facilitating the Measures' implementation. The investigation shows that researchers wrote articles and offered suggestions immediately after the Measures' promulgation, and multiple government departments formulated corresponding implementation rules according to the Measures, providing guidance for implementation. The Measures themselves contain clear work tasks and explicit division of responsibilities, pointing out the direction for implementation. Therefore, this paper argues that positive factors influencing the Measures' implementation can be explored from the aspects of scientific data value, data infrastructure, the Measures' content itself, national and governmental attention and promotion, and abundant related research.

3.1.1 Increasing Prominence of Scientific Data Value Against the background of data-intensive scientific research paradigms, scientific data is regarded as a strategic resource whose deep-level value will be continuously explored, playing greater roles in scientific research, government decision-making, national security, economic construction, and social services. For example, since the fight against COVID-19 in 2020, data from various sources has made positive contributions to epidemic prevention and control. As the dividends of scientific data continue to be released, the state will pay more attention to scientific data-related industries, and some industries may become data-oriented industries, which will undoubtedly bring great benefits to scientific data stakeholders. The value of scientific data can only be realized through rational and standardized management, making active implementation and promotion of the Measures particularly important at this time. Therefore, the continuous enhancement of scientific data value will become a positive factor promoting the Measures' implementation.

3.1.2 Gradual Improvement of Data Infrastructure In recent years, as the strategic resource and core element status and role of scientific data have become increasingly prominent and widely recognized, the state has continuously increased investment in core data infrastructure such as scientific data dedicated transmission networks and scientific data repositories, and data infrastructure has gradually improved. To implement the Measures and other relevant policies and regulations, the Ministry of Science and Technology and the Ministry of Finance have optimized and adjusted the original national science and technology resource sharing service platforms, explicitly requiring competent departments and supporting units to improve data-related infrastructure. This demonstrates the state's increasing attention to data infrastructure construction. As the Measures are further implemented, the state's investment in scientific data infrastructure will continue to increase, China's scientific data infrastructure will further transform and upgrade, and the cornerstone of scientific data management and application will be optimized and improved at a deeper level. Therefore, the gradual improvement of data infrastructure is a positive influencing factor for the Measures' implementation.

3.1.3 The Measures' Content Points Out Implementation Direction The Measures have basically established a "hierarchical management with division of responsibilities" scientific data management system based on macro, meso, and micro levels. From the specific content of the Measures, on one hand, they clarify the main work and tasks of each key link from the perspective of the scientific data lifecycle; on the other hand, they clarify the specific division of labor and responsibilities of each responsible entity from the perspective of stakeholders, requiring relevant responsible parties to perform their duties and cooperate to do scientific data management well. Scientific data responsible entities undertake three roles: implementers of higher-level policies, constructors of departmental rules and regulations, and coordinators and business promoters for lower-level units. Clear work tasks and explicit division of responsibilities provide requirements and direction for the Measures' implementation, facilitating smooth implementation. Currently, implementation rules issued by governments at all levels are based on the Measures' content and requirements, more specifically clarifying and standardizing the responsibilities and behaviors of scientific data stakeholder institutions within their jurisdictions from the perspective of the scientific data lifecycle, providing guidance for lower-level units to better implement the Measures. Therefore, the Measures' clear requirements for work tasks at each stage of scientific data and explicit division of responsibilities among responsible entities are conducive to further promoting implementation.

3.1.4 Increasing National Attention Since the 1990s, relevant departments in China have attached great importance to scientific data management, successively carrying out scientific data sharing work in meteorology, geology, hydrology, oceanography, seismology, land resources, agriculture, forestry, medicine, biology, and other fields, while formulating corresponding scientific data management policies and norms. Meanwhile, research on these policies and norms has continuously emerged, showing that China has been working for scientific data open sharing. Since the Measures' promulgation, they have attracted widespread attention from people from all walks of life, especially active response and publicity from government departments at all levels, reflecting high-level attention from all social strata. In addition, the April 9, 2020 release of the *Opinions of the CPC Central Committee and the State Council on Building a More Perfect System and Mechanism for Market-oriented Allocation of Factors of Production* requires accelerating the cultivation of the data factor market and includes data as a factor of production alongside land, labor, capital, and technology for the first time, indicating national-level recognition of data value. Therefore, all social strata will inevitably pay more attention to the Measures' implementation and promotion. The effective implementation of the Measures cannot be accomplished overnight, nor can it achieve immediate results. With continuous improvement in national attention, the Measures will be implemented in an orderly and effective manner. Therefore, increasing national attention is a positive factor influencing the

Measures' implementation.

3.1.5 Clear Promotion by Governments at All Levels According to incomplete statistics, more than 20 government departments have formulated relatively detailed implementation rules for the Measures. As competent departments for scientific data management, government agencies are currently the most prominent scientific data stakeholder institutions in promoting the Measures' implementation, playing a clear leading role. The issuance of implementation rules reflects local governments' mission and responsibility to "guard their territory with responsibility, accountability, and dedication" for scientific data. The implementation rules issued by various localities basically inherit the core content of the Measures, with some slightly supplemented or expanded. These rules also enhance the pertinence and operability of the Measures' implementation, helping other scientific data stakeholders deeply comprehend the Measures' spirit and better grasp various issues in implementation to further promote the Measures. The government's leading role and value orientation also help guide scientific data stakeholders to clarify their rights and obligations regarding the Measures' implementation, effectively guiding and constraining their behavior. Therefore, the issuance of implementation rules by governments at all levels has a relatively obvious promoting effect on the Measures' implementation and is a positive factor influencing it.

3.1.6 Continuously Enriching Research Results A group of experts and scholars in China have long been concerned with scientific data-related work, making positive contributions to the innovation and development of China's scientific data management. Research on scientific data policies is relatively abundant, providing theoretical guidance for the formulation and implementation of relevant policies and ensuring rational and scientific management and utilization of scientific data. Moreover, some theoretical research directly related to the Measures has emerged after their promulgation. Although these research results do not directly address specific aspects of the Measures' implementation, the suggestions and thoughts proposed provide certain references for implementation. In the more than two years since the Measures' promulgation, they have continuously attracted the attention of researchers, which is sufficient to show these experts' and scholars' sense of responsibility, mission, and commitment to China's scientific data-related work. As the Measures are gradually promoted and implemented, related research will become increasingly abundant and provide more directions and guidance for the Measures' implementation, promoting their implementation. Therefore, the abundant research results after the Measures' promulgation are a positive factor influencing their implementation.

3.2 Negative Factors Influencing Implementation

Although the promulgation and implementation of the Measures provide guidance and basis for China's scientific data management, and there are positive

factors promoting their implementation, implementation faces certain difficulties in a relatively complex environment. The investigation found that most scientific data stakeholder institutions have not proposed specific requirements or clear plans for the Measures' implementation, corresponding implementation mechanisms need further improvement, and the Measures mainly target scientific data stakeholder institutions without explicitly defining the rights and responsibilities of individual scientific data stakeholders. This inevitably leads to inadequate understanding of the Measures' spirit and weak implementation awareness. Currently, academic discussions on the Measures are gradually increasing, but most focus on content interpretation and significance explanation, with very few considering implementation. Therefore, this paper argues that negative factors influencing the Measures' implementation can be explored from the aspects of weak individual awareness, lack of explicit requirements and planning by relevant institutions, absence of supervision mechanisms, and insufficient implementation research.

3.2.1 Weak Awareness Among Individual Stakeholders The Measures mainly target scientific data stakeholder institutions such as government departments, research institutes, higher education institutions, and data centers, providing sufficient guidance, constraints, and regulations on their management, responsibilities, and tasks. However, they do not directly reflect constraints on the behavior of individual stakeholders such as data producers, managers, users, and service providers, nor do they specify the rights individuals should have regarding data. Although implementation rules are more specific, they are basically similar. With the continuous advancement of scientific data research and practice, although the awareness of scientific data stakeholders has improved, at the implementation level, due to personal interest conflicts, unclear data rights and responsibilities, and the Measures' lack of provisions on individual behavior, individual stakeholders such as researchers, practitioners, and managers have inadequate understanding of the Measures' spirit, weak scientific data management awareness, and still engage in arbitrary data processing or are unwilling to share data for various reasons. Therefore, weak individual awareness is a negative influencing factor for the Measures' implementation and promotion.

3.2.2 Lack of Explicit Requirements by Stakeholder Institutions The investigation shows that many scientific data stakeholder institutions have not made further requirements for the Measures' implementation. Only a few academic journals, data centers/platforms, and individual universities require scientific data submission and management according to the Measures. Peng Lin and Han Yanli investigated and analyzed the data policies of 65 SCI-indexed English-language academic journals sponsored by the Chinese Academy of Sciences, finding that 37 journals (57%) had formulated encouraging data policies, but these were imperfect in some aspects, and domestic scientific journals need to further improve their data policies. However, most domestic academic journals have not

required contributors to submit data supporting their papers (except for papers that do not generate data), and many data centers/platforms and universities have not formulated more detailed implementation plans or rules suitable for their units according to the Measures. The provisions of the Measures mainly guide and constrain the behavior of scientific data stakeholder institutions, and the core element of institutions is people. Therefore, the ultimate implementation of the Measures must first be led by scientific data stakeholder institutions to drive individual stakeholders' self-discipline and consciousness. If institutions have weak or no awareness, individual execution will be greatly reduced. Since most institutions have not made further requirements for scientific data management according to the Measures, institutional implementation failure is a negative factor affecting further implementation.

3.2.3 No Clear Planning for Implementation Promotion Reading through the Measures reveals that they contain mostly declaratory provisions, with relatively few empowering and prohibitive provisions. Declaratory provisions generally tell us "what should be done," while empowering and prohibitive provisions usually tell the public "specifically what to do or what not to do." Although the Measures and local implementation rules have shown attitudes toward scientific data management, their specific content still contains many abstract declaratory provisions, with fewer operational empowering and prohibitive provisions. Moreover, scientific data stakeholder institutions do not have clear plans for promoting the Measures' implementation. Therefore, competent departments, legal entities, and data centers need to discuss and formulate specific management systems based on the Measures and implementation rules to actively promote effective implementation. It is recommended that scientific data stakeholder institutions include the Measures' implementation plans in their 14th Five-Year Plans or formulate special implementation promotion plans.

3.2.4 No Established Supervision Mechanism for Implementation Article 30 of the Measures explicitly requires that "competent departments and legal entities should establish and improve evaluation and assessment systems for scientific data management and open sharing work." Throughout the implementation rules issued by various provinces, only a few, such as Heilongjiang Province, have conducted some exploration, requiring that "legal entities and scientific data centers conduct annual self-assessment of data management work, and competent departments conduct assessments of affiliated legal entities and data centers through user evaluation and online testing." No relevant provisions were found in many other provinces and cities. The purpose of establishing evaluation and assessment mechanisms is to identify the strengths and weaknesses of stakeholders' scientific data management work, thereby promoting targeted improvement—an important measure for better implementing the Measures. However, evaluation and assessment mechanisms alone are insufficient. The Measures' implementation also requires competent departments to establish

corresponding supervision mechanisms according to the Measures' provisions, benchmarking against the actions of scientific data stakeholder institutions. Establishing scientific and effective supervision mechanisms can accurately grasp the degree of the Measures' implementation, clarify existing problems and difficulties, and facilitate active problem-solving. Overall, no scientific data stakeholder institution has explicitly established a supervision mechanism for the Measures' implementation, making this a negative factor affecting implementation.

3.2.5 Insufficient Research on the Measures' Implementation The Measures have attracted attention from all parties since their promulgation, and some academic discussions have emerged. However, current research on the Measures mostly consists of academic achievements on significance elaboration and content interpretation, with very few thoughts on implementation and extremely insufficient specific practical research and implementation considerations. The implementation of any work requires active research and deployment, and the Measures' implementation requires contributions of ideas from all parties, with advance prediction and full estimation of possible problems and difficulties. Research is needed on how to fully mobilize the enthusiasm, initiative, and self-discipline of scientific data stakeholders and on the feasibility of incentive mechanisms from an academic perspective. The Measures' implementation is a long-term project requiring evaluation of effects at various stages, and research on constructing implementation effectiveness evaluation indicators should also be put on the agenda. Theory guides practice, so the Measures' implementation requires research to provide theoretical guidance; practice tests theory, and the Measures' implementation process can also test related research results. However, current in-depth research on the Measures' implementation is extremely insufficient, making this a negative factor affecting implementation.

4 Promotion Strategies for the Measures' Implementation

Based on the current implementation status and in combination with positive and negative influencing factors, this paper proposes several strategies to provide reference for promoting further implementation of the Measures.

4.1 Enhancing Awareness: Comprehending the Measures' Spirit

The investigation results and previous discussion show that some scientific data stakeholders have insufficient understanding of the Measures' spirit and do not pay enough attention to their implementation. Some institutions have not made explicit requirements or plans for the Measures' implementation, and some individuals have weak awareness of implementation. Therefore, we can enhance ideological awareness, strengthen implementation requirements, make active arrangements and deployments, formulate clear plans, and actively perform duties from the perspectives of scientific data stakeholder institutions and individuals. Scientific data stakeholder institutions must perform their duties ac-

cording to the Measures' provisions and requirements, strengthen responsibility implementation, and competent departments must strictly require implementation. Higher-level units should strengthen guidance and guide implementation in lower-level units, forming a comprehensive linkage mechanism for promoting the Measures. Individual stakeholders such as scientific data producers, managers, service providers, and users need self-discipline and consciousness, actively study and comprehend the Measures' spirit, and assume responsibilities and standardize behavior according to their roles in scientific data management. Individual stakeholders are key to the Measures' implementation, as each implementation link ultimately rests on individuals. Therefore, relevant institutions must attach great importance to guiding individual behavior while doing their own work well, inviting domain experts for training or discussions when necessary to improve individual understanding and comprehension, attach importance from an ideological perspective, and actively participate in their institutions' scientific data management work and perform their duties. Only when scientific data stakeholders enhance their awareness and attach great importance to the significance of the Measures' implementation from an ideological perspective can the Measures be better and faster implemented, contributing to China's scientific data cause.

4.2 Strengthening Research: Guiding the Measures' Implementation

In terms of content, the Measures are general policies that mainly put forward requirements from a macro level without providing detailed rules from a micro level. For example, Article 9 clearly stipulates that relevant research institutes, higher education institutions, and enterprises need to "establish and improve their own scientific data-related management systems," but in practice, there is a lack of scientific data-related management system construction in higher education institutions and enterprises, requiring these legal entities to make efforts to fill the gaps in scientific data management. The Measures' provisions mainly guide and constrain the behavior of scientific data stakeholder institutions, and the core element of institutions is people. Therefore, the Measures' ultimate implementation must first be led by scientific data stakeholder institutions to drive individual stakeholders' self-discipline and consciousness. If institutions are in a state of weak or no awareness, individual execution will be greatly reduced. Since most institutions have not made further requirements for scientific data management according to the Measures, institutional implementation failure is a negative factor affecting further implementation.

4.3 Establishing Systems and Mechanisms: Building Implementation Mechanisms for the Measures

The Measures' promulgation has guided the successive issuance of implementation rules in multiple provinces and cities, pointing out the direction and providing the basis for local scientific data management. However, as mentioned earlier, the formulation of implementation rules by other scientific data

stakeholder institutions is unsatisfactory, with only a few having been issued. Therefore, scientific data stakeholder institutions should research, formulate, or actively improve their own scientific data management policies or systems (such as scientific data quality control systems and scientific data submission and preservation systems), earnestly perform their duties, and play their roles in scientific data management. The effective implementation of the Measures and their implementation rules requires establishing a series of mechanisms conducive to promoting related work: (1) **Incentive mechanism:** Unsmooth incentive mechanisms are not conducive to mobilizing the enthusiasm and initiative of scientific data stakeholders, thus failing to provide strong guarantees for the Measures' implementation. (2) **Feedback mechanism:** Through various means, timely investigation and guidance of scientific data stakeholder institutions enable relevant departments to promptly grasp the Measures' implementation dynamics and solve existing problems. (3) **Supervision mechanism:** A sound supervision mechanism can urge the orderly, effective, and forceful implementation of the Measures and constrain the behavior of scientific data stakeholders. (4) **Evaluation mechanism:** Establishing an evaluation mechanism and constructing scientific and reasonable evaluation indicators can effectively evaluate the effectiveness of the Measures' implementation. (5) **Social participation mechanism:** Introducing broad social participation and guiding stakeholders to contribute wisdom to the Measures' implementation can achieve win-win economic and social benefits. In addition, relevant departments should build talent teams, cultivate qualified scientific data management personnel, strengthen scientific data security protection and privacy protection for scientific data stakeholders, and eliminate stakeholders' security concerns.

4.4 Mutual Learning: Stakeholders Need to Cooperate Fully

Although China has achieved certain results in scientific data management, deficiencies remain in some aspects, and the development of scientific data management across different regions, disciplines, stakeholder institutions, and lifecycle stages is unbalanced and insufficient. This phenomenon also exists in the Measures' implementation process, with different scientific data stakeholders implementing the Measures to varying degrees and with different characteristics. Stakeholders in the same/different disciplines, same/different types, and same/different regions will accumulate different experiences and face different problems in implementing the Measures. Therefore, stakeholders should strengthen exchanges and cooperation, share experiences for reference, collectively solve problems through collective wisdom, and form a good situation of complementary advantages and mutual learning. Consider establishing a three-dimensional exchange system led by competent departments, with legal entities actively participating, scientific data centers fully cooperating, and individual scientific data stakeholders collaborating. All participants should actively share experiences while actively learning from other reference experiences and practices to promote the Measures' implementation. It should be noted that reference and learning should not blindly copy others' practices but should fully

consider one's own circumstances, strive to absorb aspects conducive to promoting the Measures' implementation, and actively think about one's own deficiencies and problems while actively improving and solving them. In addition, consider cross-domain integration and innovation, exchange and cooperate with implementation entities of other similar policies and regulations, learn from each other's experiences, and actively promote the Measures' implementation. The Measures' implementation has no completion time, only continuous progress. Only through collective wisdom and cooperation can the scientific data management cause be pushed forward.

The *Scientific Data Management Measures*, as China's first national-level management measure for all-domain scientific data, provides an action guide for China's scientific data management, making scientific data management work rule-based and standardized. The measures proposed in the Measures all address the shortcomings of China's scientific data management and are significant for promoting economic and social development and scientific and technological innovation upgrading. More than two years have passed since the Measures were issued in March 2018. They have attracted strong attention and positive evaluation from relevant parties. This study finds that government departments at all levels are the main force in promoting the Measures' implementation. Other scientific data stakeholder institutions are also actively implementing the Measures but acting slowly, with significant gaps in implementation degrees among different stakeholders and serious imbalance and insufficiency. The overall implementation status is not optimistic and requires further promotion. This status may be related to the short time since the Measures' promulgation. In response to existing problems, this paper also proposes promotion strategies for the Measures' implementation.

Policies and regulations are formulated to standardize work in industry fields. Only when policies and regulations are truly implemented can they guide practical work in the field. This paper aims to stimulate academic discussion on related issues, hoping to attract academic attention and strengthen research, and expecting the proposed measures to provide reference for the Measures' implementation.

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Author Contributions: Li Yang: Responsible for topic selection, proposing the paper framework, determining writing ideas, and writing the initial draft. Wen Liangming: Adjusted the paper framework, conducted web-based investigation, revised the paper, and finalized the manuscript.

Impact and Influence of *Library and Information Service* in 2020

In 2020, this journal continued to rank second in Peking University's *Core Journals Catalog*, was listed as a core journal in Nanjing University's *Chinese Humanities and Social Sciences Core Journals Catalog*, was rated as an authoritative journal (A+) in Wuhan University's *Chinese Academic Journal Evaluation Research Report* (RCCSE), was listed as a core journal in the Institute of Scientific and Technical Information of China's *Chinese Science and Technology Core Journals Catalog*, ranked second in its discipline in CNKI's *Chinese Academic Journal Impact Factor Annual Report* (Q1 zone), and was selected as one of the "Most Internationally Influential Chinese Academic Journals" (two journals in library and information science were selected). It is also gratifying that the journal was included in the *High-Quality Journal Recommendation List in Management Science* led by the China Association for Science and Technology and released by relevant management science communities (seven journals in library and information science were selected), indicating the acceptance and recognition of library and information science academic journals by the management discipline.

Library and Information Service Editorial Office
December 2020

Note: Figure translations are in progress. See original paper for figures.