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A review of four-dimensional coordination mechanism for the dissemination of library scientists spirit under the theory of value creation

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Abstract: This study, grounded in value co-creation theory, employs a comprehensive approach combining literature review and case analysis to investigate the four-dimensional collaborative mechanism for disseminating the spirit of scientists in libraries. Through systematic examination of domestic and international literature, we systematically analyze current research developments and evolutionary trends in this field. By examining representative cases, we identify both successful practices and existing challenges in library-based the spirit of scientists communication. The research reveals that this four-dimensional mechanism encompasses four key dimensions: resources, technology, services, and management, which work synergistically to enhance the effective dissemination of scientific ethos. Specifically, the resource dimension focuses on integrating literature, physical spaces, and human resources; the technology dimension emphasizes the application of big data, artificial intelligence, and new media technologies; the service dimension highlights customized reading initiatives, thematic exhibitions, lectures, and interactive experiences; while the management dimension addresses process optimization, incentive system refinement, and evaluation framework development. These findings provide crucial guidance for libraries to improve the spirit of scientists communication effectiveness and offer innovative approaches for future endeavors in scientific cultural preservation.

1. Introduction

1.1 The development and influence of value co-creation theory

As a pivotal theoretical framework in management science, the Value Co-creation Theory traces its origins to service-oriented logic research from the late 20th century. This theory emphasizes that the interactive collaboration between enterprises and customers serves as the primary driver of value creation, moving beyond the traditional single-supplier dominance model [1]. With evolving research, the theory has expanded from service sectors to broader industries including education, cultural heritage preservation, and knowledge dissemination. At its core, this theory advocates for collaborative resource integration, multi-stakeholder cooperation, and dynamic interaction to achieve co-creation and maximization of value, offering organizations a fresh perspective and methodological

support [1]. Particularly in the information age, its applications have broadened significantly, with proven effectiveness in fostering cross-departmental collaboration, optimizing resource allocation, and enhancing user experience. For instance, in library services, Value Co-creation Theory has been applied to explore how user participation and resource integration can improve service quality, thereby better meeting societal demands for knowledge dissemination [2]. These research findings establish a solid theoretical foundation for integrating Value Co-creation Theory into the promotion of scientists spirit, while providing crucial references for its practical implementation in library practices.

Furthermore, the impact of value co-creation theory extends beyond academic research, demonstrating significant social value in practice. In the field of science communication, this theory provides innovative approaches for collaboration among libraries, scientists, and the public. For instance, by establishing two-way interaction mechanisms, libraries can better uncover the intellectual essence of scientists and transform it into culturally shared assets [1]. Simultaneously, the theory emphasizes technology's crucial role in value creation, aligning perfectly with contemporary libraries' trend of leveraging big data and artificial intelligence to optimize communication methods [3]. Therefore, applying value co-creation theory to research on disseminating the spirit of scientists not only innovates traditional communication models but also expands pathways for preserving scientific culture. The introduction of this theoretical framework offers robust support for libraries to fulfill their mission of science communication in the new era.

1.2 The position of libraries in the dissemination of the spirit of scientists

As vital repositories of scientific and cultural heritage, libraries play an irreplaceable role in disseminating the spirit of scientists. This ethos not only constitutes the core value of the scientific community but also serves as a vital force driving societal innovation and technological advancement [4]. Leveraging their extensive collections, diverse communication channels, and broad social influence, libraries act as crucial bridges connecting scientists with the public. On one hand, they provide a solid foundation for spreading this spirit by preserving scientists 'works, research achievements, and academic literature. On the other hand, through exhibitions, lectures, and interactive events, libraries transform static resources into dynamic content that amplifies its impact across society [5]. A prime example is the "National Top Science and Technology Award Scientists' Handprint Wall" project at the China Science and Technology Museum, which concretely embodied the spirit of scientists through multimedia displays and public engagement activities, making it deeply rooted in people's consciousness [4].

Furthermore, libraries' unique advantages in disseminating the spirit of scientists are reflected in their diverse resources and universal accessibility. Whether through physical spaces or digital platforms, libraries provide multifaceted venues and channels for promoting this ethos. For instance, by establishing thematic exhibition zones or online virtual galleries, libraries can transcend time and space limitations to engage broader public participation in science communication [1]. Simultaneously, libraries demonstrate strong social mobilization capabilities. Through collaborations with research institutions, science communicators, and volunteers, they can integrate resources to amplify the impact of science communication [6]. This ability to coordinate resources and collaborative dissemination positions libraries as crucial agents in spreading the spirit of scientists, while underscoring the necessity to explore effective pathways for such cultural transmission.

1.3 Research purpose and significance

This study aims to establish a four-dimensional collaborative mechanism for disseminating the spirit of scientists in libraries under the value co-creation theory, providing theoretical guidance and practical references for library practices in scientific cultural inheritance. Specifically, by integrating

four key dimensions—resources, technology, services, and management—we explore how libraries can maximize the value of disseminating the spirit of scientists through multi-party collaboration and resource integration [7]. This research not only helps optimize library communication strategies and enhance their effectiveness, but also provides new approaches and methods for scientific cultural inheritance. Theoretically, this study applies value co-creation theory to the dissemination of the spirit of scientists in libraries, expanding its application scope while enriching interdisciplinary research achievements in library science and management [5].

In practical terms, this study demonstrates significance through three key dimensions: First, by establishing a four-dimensional collaborative framework, libraries can more effectively integrate internal and external resources, thereby enhancing both the quality and reach of disseminating the spirit of scientists [1]. Second, this mechanism emphasizes the deep integration of technology and services, enabling libraries to leverage emerging technologies like big data analytics and artificial intelligence to precisely meet audience needs and amplify communication impact [7]. Finally, through optimizing management processes and refining incentive mechanisms, libraries can stimulate staff motivation and creativity, ensuring effective implementation of dissemination initiatives [8]. In summary, this research not only provides a systematic theoretical framework for promoting the spirit of scientists in libraries but also offers concrete operational guidance, demonstrating significant theoretical value and practical relevance.

2. Literature review

2.1 Research on value co-creation theory

As a pivotal theoretical framework in management science, the Value Co-creation Theory emphasizes collaborative efforts and resource integration to achieve shared value creation and maximization. First proposed by Prahalad and Rameswamy, this theory has evolved under the service-oriented logic [5]. In practical applications, it has been widely implemented across enterprise management, marketing, public services, and other sectors, demonstrating its significant advantages in optimizing resource allocation, enhancing service efficiency, and improving user experience [7]. For instance, within corporate management, Value Co-creation establishes interactive relationships between businesses and customers to maximize product/service value. In public service domains, it enhances coverage and quality through coordinated collaboration among governments, social organizations, and the public.

From the perspective of core elements, the value co-creation theory primarily comprises three key dimensions: resource integration, interactive participation, and value sharing. Resource integration emphasizes optimizing the allocation of resources from different entities to create synergistic effects; interactive participation focuses on active collaboration among stakeholders during the value creation process; while value sharing reflects the shared benefits of created value among multiple parties [5]. These elements provide crucial theoretical support for library services. The application potential of value co-creation theory in library services is mainly reflected in three aspects: First, by integrating library literature resources, spatial resources, and technological resources, a more diversified service system can be established; Second, through user participation and feedback mechanisms, service content better aligned with audience needs can be designed; Finally, collaborations with other institutions—such as libraries partnering with research institutes and science popularization organizations—can further expand the influence and reach of scientific literacy dissemination [9].

Furthermore, the potential application of value co-creation theory in library services is also reflected in its inspiration for innovative service models. For instance, libraries can adopt crowdsourcing approaches by inviting users to participate in collecting and organizing resources related to scientific ethos. Alternatively, they may utilize social media platforms to establish

interactive communities for disseminating scientists spirit, thereby enhancing user engagement and sense of belonging [5]. Overall, value co-creation theory provides a fresh perspective and methodological support for promoting scientific ethos in libraries, laying a solid foundation for practical explorations in resource integration, service innovation, and collaborative management.

2.2 Current situation of dissemination of scientists spirit in libraries

As vital repositories of scientific and cultural heritage, libraries possess unique advantages and responsibilities in promoting the spirit of scientists. In recent years, scholars worldwide have conducted extensive research on disseminating this ethos through libraries, yielding significant academic achievements. Current studies predominantly focus on traditional methods such as exhibitions, lectures, and reading promotion initiatives, while actively exploring new media applications. A notable example is the China Science and Technology Museum, which successfully engaged audiences through its "National Top Science and Technology Award Scientists' Hand-Mold Wall" project, combining interactive exhibits and multimedia displays [4]. Similarly, the Chinese Academy of Sciences has effectively conveyed the essence of the scientific spirit to the public through thematic exhibitions and science outreach programs. These practices not only enhance public understanding but also provide valuable references for libraries in promoting the spirit of scientists.

In audience analysis, research generally focuses on the acceptance levels and demand characteristics of different groups regarding the spirit of scientists. For instance, libraries typically engage teenagers through interactive methods like hands-on science experiments and storytelling to spark interest in scientific values, while adult audiences are better served by specialized lectures and in-depth reading materials that meet their deeper needs for scientific culture [10]. Additionally, some studies explore international dissemination of the spirit of scientists, emphasizing the importance of cross-cultural communication in enhancing its global influence [11]. However, despite progress in communication approaches and audience analysis, existing research still has limitations. Most studies focus on single-dimensional analyses without systematic exploration of multi-dimensional collaborative communication mechanisms. Moreover, insufficient attention is given to leveraging emerging technologies for improved communication effectiveness, making it difficult to adapt to the demands of the information age.

Current research priorities and hot topics primarily focus on three key areas: First, the theoretical foundations and practical approaches for disseminating the spirit of scientists endeavor; second, aligning communication methods with audience needs; third, exploring the application prospects of new technologies in this field [12][4]. While these studies provide crucial theoretical support and practical guidance for promoting the spirit of scientists endeavor in libraries, they also reveal pressing challenges such as inconsistent evaluation criteria for communication effectiveness and underdeveloped mechanisms for cross-disciplinary collaboration. These issues create substantial opportunities for future research exploration.

2.3 Research gaps and trends

While existing literature has achieved certain accomplishments in disseminating the spirit of library scientists, there remains a significant gap in research on the four-dimensional collaborative mechanism under the value co-creation theory. First, current studies predominantly focus on single-dimensional analyses such as resource integration or technology application, lacking systematic exploration of the synergistic effects among resources, technology, services, and management [8]. This singular perspective fails to comprehensively reveal the intrinsic mechanisms of spreading the spirit of library scientists, thereby limiting its practical effectiveness. Second, there is insufficient research on specific applications of value co-creation theory in this context, particularly regarding

how to maximize value through multi-stakeholder collaboration. Mature theoretical frameworks and practical models have yet to emerge [13].

Furthermore, existing research in communication effectiveness evaluation remains inadequate. Most studies focus solely on the implementation process of communication activities while neglecting quantitative analysis and continuous optimization of actual outcomes [8]. This deficiency in evaluation systems makes it challenging for libraries to accurately measure the social impact of disseminating the spirit of scientists and adjust communication strategies in a timely manner to adapt to evolving societal needs. Therefore, scholars in the field should prioritize the following trends in future research: First, establish a four-dimensional collaborative mechanism model, based on value co-creation theory, to systematically analyze the interrelationships among dimensions and their impacts on communication effectiveness; Second, strengthen cross-disciplinary collaborative research to explore synergistic models between libraries and other institutions in disseminating the spirit of scientists; Third, refine the communication effectiveness evaluation system through data collection and analysis to provide scientific evidence for optimizing communication strategies.[14].

With the rapid advancement of information technology and the diversification of societal needs, research on the dissemination of the scientists spirit in libraries will increasingly emphasize intelligence, personalization, and internationalization. For instance, the application of artificial intelligence and big data technologies can help accurately analyze audience demands, thereby enabling the design of more targeted communication content. The integration of new media platforms can expand the reach of dissemination and enhance the global influence of the scientists spirit [8]. In summary, future research should combine theoretical innovation with practical exploration to continuously advance the four-dimensional collaborative mechanism studies for disseminating the scientists spirit in libraries, pushing them toward deeper development.

3. Applicability of value co-creation theory in the dissemination of scientists spirit in libraries

3.1 The convergence point between value co-creation theory and library service

The Value Co-creation Theory emphasizes collaborative value creation through multi-stakeholder partnerships and resource integration, which aligns closely with the core mission of library services. As vital institutions for knowledge management and dissemination, libraries aim to meet user needs, facilitate knowledge circulation, and preserve cultural heritage, with this theory providing innovative perspectives and methodological support [15]. In promoting the spirit of scientists inquiry, libraries must not only integrate researchers 'publications and academic resources but also collaborate with scientists, science communicators, and the public to build a multi-stakeholder ecosystem [7]. This collaborative model enhances service depth and breadth, amplifying libraries' impact in science communication. For instance, through two-way initiatives like "sending science communicators out" and "inviting scientists in," libraries can establish close ties with experts, combining scientific expertise with their own resources to create mutually beneficial partnerships [1]. Furthermore, the theory's emphasis on efficient resource allocation aligns with libraries' needs for integrating spatial and technological resources, offering fresh approaches for disseminating the spirit of scientists inquiry.

3.2 The significance of value co-creation theory to the dissemination of scientists spirit

The Value Co-creation Theory plays a vital role in optimizing communication processes, enhancing dissemination effectiveness, and boosting audience engagement for spreading the spirit of scientists in libraries. First, by emphasizing multi-party collaboration and resource integration, this theory significantly improves the communication process of scientific ethos. In traditional models where scientists act as sole information providers while libraries serve as mere information transmitters, this

one-way communication often leads to information loss and insufficient audience participation. However, through establishing dialogue mechanisms based on Value Co-creation Theory, libraries can integrate scientists, science communicators, and audiences into a unified communication system, enabling two-way information flow and deep interaction [5]. Second, the theory enhances the effectiveness of spreading the spirit of scientists. By precisely analyzing audience needs and leveraging big data and AI technologies, libraries can deliver personalized content recommendations, thereby improving communication relevance and impact [13]. Finally, it strengthens audience engagement and sense of belonging. Through interactive experiences like science experiment demonstrations and scientist storytelling sessions, libraries can spark audience interest and enthusiasm, transforming passive recipients into active participants who deepen their understanding and recognition of the scientific ethos [5].

3.3 Construction of the spiritual communication model of library scientists based on value co-creation theory

Building upon the Value Co-creation Theory, this study proposes a model for disseminating the spirit of scientists excellence in libraries. The framework identifies key stakeholders and their interconnections while establishing a four-dimensional collaborative mechanism. The model comprises four core components: scientists, libraries, audiences, and technological platforms. Scientists, as knowledge producers and communicators, provide scientific content and practical expertise. Libraries act as resource integrators and service providers, handling document management, spatial resource utilization, and technical support. Audiences, crucial participants in value co-creation, enhance content quality through feedback and engagement. Technological platforms serve as bridges connecting stakeholders, enabling information exchange [1][5]. Operationally, the model emphasizes collaboration and resource integration. For instance, libraries can invite scientists to curate exhibitions and lectures while leveraging new media platforms to expand reach, creating an online-offline integrated communication network [13]. Additionally, the model incorporates evaluation mechanisms to optimize strategies and maximize impact through systematic assessment [7]. This framework not only provides theoretical foundations for library-based dissemination of scientific excellence but also establishes a robust basis for subsequent research on four-dimensional collaborative mechanisms.

4. The resource dimension of the four-dimensional coordination mechanism for the dissemination of scientists spirit in libraries

4.1 Literature resource integration

As crucial institutions for knowledge management and dissemination, libraries play a foundational role in promoting the spirit of scientists through systematic integration of their resources. By systematically collecting, organizing, and digitizing scientific works, research achievements, academic papers, and other literature, libraries can establish specialized databases that provide rich content support for spreading the spirit of scientists. For instance, during exhibition renovations at the China Science and Technology Museum, elements of scientists spirit were fully integrated through collecting scientists 'handprints, recording motivational videos, and other forms, effectively combining research achievements with their spiritual essence [4]. This practice not only showcases academic accomplishments but also conveys the spirit of pursuing truth and courageous exploration. Additionally, libraries can collaborate with research institutions to acquire primary scientific materials, further enriching their collections. Yuan Hui's research indicates that library knowledge production involves editing, processing, and innovating collection information resources—a process that significantly enhances the value of knowledge products [7]. Therefore, libraries should fully utilize

modern information technology to deeply mine and redevelop scientific literature resources, creating educational and communicative thematic databases that establish solid resource foundations for spreading the spirit of scientists.

4.2 Utilization of space resources

Libraries serve as vital platforms for promoting the spirit of scientists through both physical and virtual spaces. In physical environments, libraries can cultivate a vibrant scientific culture by establishing dedicated exhibition zones and scientist memorial corners. A prime example is the "National Top Science and Technology Award Scientists 'Handprint Wall" project at the China Science and Technology Museum, which permanently displays scientists' handprints and video messages in public spaces, attracting massive public engagement [4]. This spatial design not only enhances tangible connections with scientific heritage but also provides concrete venues for science communication. In virtual realms, libraries can leverage new media technologies to create online exhibition halls that transcend time and space limitations, expanding the reach of scientific ethos dissemination. Research on cultural-tourism integration reveals that libraries collaborating with tourist attractions and cultural institutions can integrate their resources into tourism value chains, achieving resource sharing and functional complementarity [12]. This model applies equally to science communication, where virtual reality technology can recreate research environments or social media platforms host online exhibitions and interactive activities, allowing audiences to experience the allure of scientists spirit through diverse scenarios. In conclusion, libraries should fully utilize both physical and virtual resources to build multidimensional communication platforms, thereby enhancing the effectiveness and influence of science spirit dissemination.

4.3 Human resource collaboration

In promoting the spirit of scientists, libraries need to collaborate with various human resources to deepen communication efforts. First, libraries should establish close ties with scientists, fully leveraging their leading role in scientific content creation. As mentioned in reference [1], "encouraging science communicators to 'go out' " serves as a crucial pathway for library-scientist collaboration. Science communicators can visit research institutions to understand scientists' communication needs, provide consultation and skills training services, while helping scientists transform complex research findings into accessible content. Second, libraries should strengthen cooperation with science communicators to design diverse communication activities through their expertise. For instance, inviting science writers to compose biographies of scientists and organizing public lectures can effectively convey the core values of the scientist spirit. Additionally, volunteers, as a vital supplement to library services, can play an active role in spreading this spirit. Reference [6] emphasizes that the dissemination of the scientist spirit requires multi-stakeholder participation to create synergistic effects. Therefore, libraries should establish comprehensive volunteer recruitment and training mechanisms to attract more science enthusiasts. By integrating resources from scientists, science communicators, and volunteers, libraries can build an efficient collaborative network, providing robust support for the widespread promotion of the scientist spirit.

5. The technical dimension of the four-dimensional cooperative mechanism for the dissemination of scientists spirit in libraries

5.1 Application of big data technology

Amid the rapid advancement of information technology, big data analytics has provided innovative

technical support for disseminating the spirit of scientists inquiry in libraries. Through comprehensive analysis, libraries can accurately identify audience needs and interests, thereby optimizing both the content and delivery methods of such cultural promotion. Specifically, big data technology integrates multi-source data including user borrowing records, online browsing patterns, and social media interactions to build detailed user profiles and uncover latent demands [7]. For instance, by analyzing readers' preferences and historical access patterns, libraries can pinpoint specific groups interested in scientific inquiry and deliver personalized content tailored to their needs. This data-driven precision recommendation system not only enhances communication efficiency but also significantly improves the relevance and effectiveness of information dissemination [10].

Furthermore, big data technology enables libraries to monitor communication effectiveness in real-time and dynamically adjust strategies. Through in-depth analysis of feedback data generated during dissemination processes, libraries can evaluate the actual impact of various communication formats, such as exhibition attendance numbers, online event engagement rates, and user satisfaction. These data provide scientific decision-making foundations, allowing libraries to continuously optimize resource allocation and content design throughout the communication process, thereby better meeting audience needs. Notably, the application of big data technology is not standalone but requires integration with other technical approaches to achieve more efficient communication objectives. For instance, when consolidating literature resources, big data technology can collaborate with artificial intelligence algorithms to further enhance intelligent information processing capabilities [7].

5.2 Assistance of artificial intelligence technology

The application of artificial intelligence technology in disseminating the spirit of scientists in libraries primarily manifests in two aspects: intelligent recommendation systems and smart Q&A platforms. These features significantly enhance communication efficiency and interactivity. First, intelligent recommendation systems can automatically generate personalized content lists based on users 'interests and behavioral patterns. For instance, when a user shows interest in a scientist's research achievements, the system may recommend relevant publications, papers, or multimedia resources to guide deeper exploration of the essence of scientists spirit [7]. This intelligent recommendation not only reduces time costs for information searches but also improves content relevance, making the dissemination of the scientists spirit more efficient.

Secondly, the implementation of intelligent Q&A systems has enhanced interactive communication in promoting the spirit of scientists within libraries. Through natural language processing technology, these systems can provide real-time responses to users' inquiries about scientific ethos, offering timely and accurate answers regarding both historical figures and academic achievements [10]. This interactive approach not only boosts user engagement but also deepens their understanding and appreciation of the scientific ethos. Furthermore, AI technology can analyze trending topics and patterns in user queries, providing valuable insights for libraries to optimize their content delivery strategies. For instance, by analyzing high-frequency questions, libraries can identify key areas of public interest and strategically reinforce these aspects in subsequent outreach initiatives [7].

5.3 Integration of new media technologies

The widespread adoption of new media technologies has created a more extensive dissemination platform and diversified communication formats for promoting the spirit of scientists endeavor in libraries. The rise of social media platforms like Weibo and short video platforms has enabled the spread of scientific ethos to transcend traditional media constraints, reaching broader audiences. For instance, libraries can utilize social media channels such as Weibo and WeChat Official Accounts to publish short videos or visually-rich posts about scientists 'stories, effectively engaging younger

generations [10]. This approach not only aligns with contemporary readers' preferences but also sparks emotional resonance within short timeframes, thereby enhancing communication effectiveness.

The application of short video platforms has further enriched the forms of disseminating the spirit of scientists. By creating engaging and entertaining short video content, libraries can transform abstract scientific concepts into tangible experiences that are more accessible and relatable to audiences. For instance, using animation technology to recreate scientists 'experimental scenarios or staging role-play dramas to portray their developmental journeys can effectively spark viewers' interest and provoke critical thinking [13]. Moreover, new media technologies possess powerful dissemination capabilities that enable rapid content spread through user sharing and reposting, thereby amplifying the impact of scientific spirit promotion. However, the integration of new media technologies also presents challenges such as quality control for graphic content and ensuring sustainable communication effectiveness, which require libraries to continuously explore and refine their practices in real-world applications [10].

6. Service dimension of four-dimensional coordination mechanism for the dissemination of scientists spirit in libraries

6.1 Customized reading promotion

As a vital platform for science and culture dissemination, libraries can effectively meet diverse audience needs through customized reading promotion activities, thereby enhancing the precision and effectiveness of spreading the spirit of scientists. Tailored to different age groups, libraries can design varied reading recommendation programs. For instance, youth-oriented programs could feature vivid science popularization books with rich illustrations, complemented by thematic recommendations highlighting scientists 'life stories. Adult audiences might benefit from academic monographs or research papers that delve into the essence and practical significance of scientific spirit [4]. Additionally, libraries can utilize big data analytics to analyze readers' preferences and behavioral patterns, providing personalized book recommendations. This demand-driven service model not only embodies the core principles of value co-creation theory but also significantly boosts audience engagement and satisfaction [7]. By integrating scientists' research achievements with their inspiring life stories, libraries can achieve profound exploration and dissemination of spiritual values during knowledge transmission.

Meanwhile, libraries should emphasize innovative and diversified approaches in promoting customized reading programs. For instance, they could organize hybrid events combining online and offline formats, such as virtual book clubs and in-person exhibitions featuring scientists 'works, to attract broader participation. Additionally, libraries may collaborate with other organizations to develop targeted reading resources for specific demographics. A prime example would be partnering with schools to launch "Scientific Spirit on Campus" initiatives, providing students with tailored reading materials and study guides [4]. These measures not only enrich library services but also create new pathways for disseminating the spirit of scientific inquiry. Ultimately, as a crucial component of service delivery, customized reading promotion strategies can significantly enhance libraries' influence and reach in promoting scientific values through precise and personalized approaches.

6.2 Special exhibitions and lectures

Themed exhibitions and lectures serve as vital platforms for libraries to convey the spirit of scientists. Through vivid displays and in-depth explanations, they effectively showcase the intellectual world and noble character of scientists. When designing such exhibitions, libraries can leverage multimedia technologies and interactive methods to create immersive experiences. For instance,

installing scientist hand-mold walls and screening motivational videos allow audiences to closely engage with the researchers 'struggles and aspirations [4]. Exhibitions should emphasize blending storytelling with educational value by presenting authentic cases of scientific endeavors, highlighting perseverance and exploratory spirit. This narrative-driven approach not only captures viewers' interest but also sparks profound reflection on the essence of scientific endeavor.

In terms of lecture formats, libraries can invite scientists themselves or their family members and colleagues to participate. By sharing firsthand accounts, these events enhance the authenticity and appeal of the lectures. For instance, stories about researchers overcoming challenges in their scientific careers and achieving breakthroughs can inspire audiences to emulate the spirit of scientific inquiry [14]. Additionally, libraries could design contemporary lecture themes that address trending social issues. Take, for example, exploring how the spirit of scientists drives technological progress through discussions on cutting-edge developments in science. Such timely content not only attracts broader audience engagement but also sparks public interest in scientific culture. Through the organic integration of thematic exhibitions and lectures, libraries can effectively promote the spirit of scientists while elevating their social influence and cultural value.

6.3 Interactive experience activities

Interactive experiential activities serve as vital tools for libraries to deepen audiences' understanding of the scientific spirit. Through hands-on experiments and storytelling about scientists, these programs enable participants to develop profound emotional connections and value recognition during engagement. First, scientific experiment experiences allow audiences to directly participate in the process of scientific exploration, providing a vivid demonstration of the innovative spirit and practical skills scientists exhibit in their research. For instance, libraries could design interactive programs based on classic scientific experiments, enabling participants to grasp scientific principles through hands-on activities while experiencing both the challenges and joys scientists face when exploring uncharted territories [4]. This edutainment approach not only sparks scientific curiosity but also cultivates independent thinking and problem-solving abilities.

Secondly, science communicator storytelling initiatives present scientists 'life stories and spiritual qualities through artistic forms like drama and role-playing. For instance, libraries can organize volunteer teams to adapt real-life scientific research narratives into short plays or situational dramas performed in public spaces. This dynamic presentation not only captures audience attention but also allows viewers to experience the grandeur of scientific spirit during performances [10]. Furthermore, libraries can leverage new media technologies to develop virtual interactive experiences. Using augmented reality (AR) technology, audiences can virtually participate in scientists' experimental processes within digital environments, achieving more immersive engagement. Through diversified interactive design, libraries effectively enhance public understanding and identification with scientific ethos, thereby promoting deep cultural dissemination and value co-creation in science.

7. Management dimension of four-dimensional coordination mechanism for dissemination of scientists spirit in libraries

7.1 Management process optimization

As a vital platform for disseminating the spirit of scientific endeavor, optimizing library management processes is crucial for ensuring efficient and well-organized communication initiatives. Guided by the Value Co-Creation Theory, libraries should implement systematic management approaches to achieve coordinated operations across resources, technologies, and services. First, process optimization requires cross-departmental collaboration to break down traditional functional

barriers and establish flexible user-centric workflows. For instance, libraries could create dedicated project teams for science communication to integrate internal resources and coordinate the design and execution of communication activities, thereby addressing inefficiencies caused by information asymmetry between departments [1]. Second, adopting advanced management tools like project management software and data analytics platforms can significantly enhance the scientific rigor of decision-making and operational precision. Additionally, libraries should strengthen external partnerships with research institutes and educational institutions through collaborative mechanisms to jointly develop communication strategies and conduct effectiveness evaluations, maximizing dissemination outcomes [5].

In practical implementation, optimizing management processes requires attention to detail. For instance, during the planning phase, libraries should thoroughly research target audiences' needs and preferences, combining them with the core values of scientific spirit to design engaging and targeted communication content. During execution, clearly defined roles and responsibilities ensure smooth task coordination. Post-event, timely summarization of lessons helps inform improvements for future campaigns. Through these measures, libraries can maintain efficient operations in complex environments, establishing a solid management foundation for promoting scientific spirit.

7.2 Improve the incentive mechanism

The refinement of incentive mechanisms serves as a vital tool to motivate librarians in promoting the spirit of scientific inquiry. Within the framework of value co-creation theory, libraries should establish a multi-tiered incentive system that addresses diverse needs and enhances staff motivation. Firstly, material incentives remain a primary approach. By creating special awards or performance-based rewards, libraries can recognize and reward librarians who excel in disseminating scientific values. This method not only boosts professional enthusiasm but also strengthens their sense of identity and belonging in the mission [5]. Secondly, spiritual recognition proves equally essential. Through public acknowledgment via award ceremonies and honorary certificates, libraries can elevate staff's professional pride and sense of accomplishment.

Furthermore, libraries should prioritize career development incentives by providing staff with learning and growth opportunities. For instance, organizing specialized lectures and training programs can help librarians acquire knowledge and skills in disseminating the spirit of scientists. Simultaneously, establishing career advancement pathways and professional development plans enables them to continuously realize their self-worth in their work [6]. Notably, incentive mechanisms should be designed with individual differences in mind, creating personalized schemes tailored to librarians of different ages, genders, and positions to ensure effectiveness and sustainability. Through well-established incentive systems, libraries can build a high-quality, efficient communication team that provides robust support for the widespread dissemination of scientific spirit.

7.3 Construction of evaluation system

The development of an evaluation system serves as a crucial safeguard for the continuous improvement of library science communication initiatives. Guided by the theory of value co-creation, libraries should establish a scientific and systematic assessment framework that combines quantitative analysis with qualitative evaluation to refine communication strategies and mechanisms. First, the evaluation system must clearly define metrics covering all aspects of communication activities, including content quality, audience feedback, and social impact. For instance, libraries can collect audience satisfaction surveys and improvement suggestions through questionnaires and interviews, while leveraging big data analytics to assess content coverage and audience behavior patterns, thereby gaining a comprehensive understanding of communication effectiveness [7].

Secondly, the implementation of the evaluation system should emphasize data-driven decision-making. Libraries should establish dedicated platforms for data collection and analysis to regularly monitor key metrics of communication activities, then adjust strategies promptly based on data insights. For instance, when content fails to meet expected outcomes, libraries can analyze audience feedback to optimize presentation formats or adapt distribution channels, thereby enhancing communication effectiveness [14]. Moreover, the evaluation framework must incorporate dynamic adjustment capabilities that allow flexible updates to assessment criteria and methodologies according to environmental changes and evolving user needs. Through such scientific evaluation systems, libraries not only improve the quality and efficiency of communication efforts but also provide valuable experience and reference points for future practices.

8. Case study on the dissemination of library scientist spirit based on four-dimensional collaboration mechanism

8.1 Case selection and introduction

To explore libraries 'role in disseminating the spirit of scientists, this study selects the China Science and Technology Museum (CSTM) as a case study. As a cornerstone of China's science education infrastructure, CSTM plays a vital role in popularizing scientific knowledge and promoting the spirit of scientists [4]. With its diverse exhibitions and multifaceted educational programs, the museum has pioneered innovative approaches to spreading this ethos, offering valuable lessons for other libraries and science communication institutions. The study also examines the Chinese Academy of Sciences Library and Information Center (CAS Library), which leverages its robust research resources to develop distinctive service models for science literacy initiatives [14]. These two institutions represent two distinct cultural communication entities: museums and academic research libraries, respectively, with their practices demonstrating strong representativeness in science communication contexts.

Since 2019, the China Science and Technology Museum has consistently organized the "Promoting the Spirit of Scientists" thematic exhibition series. Through interactive exhibits, scientific artifacts, graphic panels, and multimedia displays, it integrates elements of the scientists 'spirit into its content. For instance, the "National Top Science and Technology Award Scientists' Hand-Mold Wall" project collected video messages and hand molds from award-winning scientists like Yuan Longping and Tu Youyou, which are permanently displayed in public spaces and have been widely appreciated by audiences [4]. Meanwhile, the CAS Literature Center leverages the institution's rich research resources to conduct public lectures on scientists' stories and exhibitions of scientific achievements. Additionally, it has established a specialized database on the spirit of scientists through digital platforms, providing a solid resource foundation for dissemination efforts [14]. These practices not only demonstrate proactive explorations in spreading the spirit of scientists but also lay a robust foundation for subsequent analysis of the four-dimensional collaborative mechanism.

8.2 Application analysis of four-dimensional coordination mechanism

In terms of resource development, the China Science and Technology Museum has effectively integrated physical exhibits with digital resources by tapping into existing collections to create highly interactive public engagement programs. For instance, during renovations of exhibition halls like "Energy World" and "Earth Home", the museum incorporated elements of scientific ethos, allowing visitors to experience the spirit of exploration through hands-on activities [4]. Meanwhile, the CAS Literature Center leveraged its extensive archival resources to establish a specialized database on scientific ethos, providing researchers and the public with convenient access [14]. Both institutions

emphasize collaborative human resource development, working with scientists, science communicators, and volunteers to jointly promote the dissemination of scientific spirit.

From a technological perspective, the China Science and Technology Museum has expanded its reach through new media platforms. For instance, it publishes video clips featuring scientists' stories on short video platforms and utilizes big data analytics to optimize content delivery based on audience preferences [4]. Meanwhile, the Literature Center of the Chinese Academy of Sciences has developed AI-powered recommendation systems that provide personalized learning resources about scientific spirit, significantly enhancing communication efficiency and interactivity [14]. Both institutions are actively exploring emerging technologies like virtual reality (VR) and augmented reality (AR), creating immersive experiences for audiences to further amplify their impact.

In terms of service dimensions, the China Science and Technology Museum fulfills diverse audience needs through customized reading initiatives, thematic exhibitions, lectures, and interactive experiences. For instance, the "Devoted Heart——Scientists Born with the Party" exhibition vividly showcases scientists 'stories, igniting patriotic sentiments and scientific curiosity among young people [4]. Meanwhile, the CAS Literature Center bridges the public's connection with science through events like scientist storytelling sessions and open days for research achievements, deepening audience understanding and appreciation of the scientific spirit [14].

In terms of management, the China Science and Technology Museum has optimized communication processes and established cross-departmental collaboration mechanisms to ensure orderly implementation of various activities. Additionally, the museum has set up a special incentive fund to motivate staff members to actively participate in promoting the spirit of scientific research [4]. Meanwhile, the Literature Center of the Chinese Academy of Sciences developed a scientific evaluation system, continuously refining communication strategies through data collection and analysis to enhance overall operational efficiency [14]. These measures fully demonstrate the effectiveness and feasibility of the four-dimensional coordination mechanism in practical applications.

8.3 Summary of experience and challenges

Through analyzing the aforementioned case studies, we can summarize several key success factors: First, resource integration forms the foundation. Both the China Science and Technology Museum and the Chinese Academy of Sciences Literature Center emphasize diversified resource integration, including coordinated utilization of literature resources, spatial resources, and human resources, which provides robust support for communication efforts [4][14]. Second, technological innovation serves as the critical driver. Both institutions actively adopt emerging technologies like big data and artificial intelligence to optimize content delivery and formats, significantly enhancing communication efficiency and audience engagement [1][4]. Third, service innovation stands as the core strategy. Through customized reading promotions, thematic exhibitions, and interactive experiences, both institutions successfully attract audiences across different age groups, thereby amplifying communication effectiveness [4][14]. Finally, management optimization ensures sustainability. By establishing cross-departmental collaboration mechanisms, refining incentive systems, and developing evaluation frameworks, both institutions maintain standardized and efficient communication practices.

However, the case study also reveals several challenges and issues. For instance, uneven resource allocation has led to insufficient dissemination efforts in certain regions; high costs of technology application have restricted participation from some small and medium-sized libraries; and some communication activities lack diversity, making it difficult to sustain audience engagement [1][14]. These findings offer valuable insights for other libraries promoting the four-dimensional collaboration mechanism: On one hand, they should strengthen cross-regional resource integration to narrow

dissemination gaps; on the other hand, they need to explore cost-effective technological solutions to enhance the diversity and appeal of communication activities. Additionally, future research should focus on optimizing collaborative mechanisms for disseminating the spirit of library science through policy support and social partnerships, thereby achieving broader societal impact [1][14].

9. Future development of four-dimensional collaborative mechanism for dissemination of scientists spirit in libraries

9.1 Development trend outlook

With the rapid advancement of technology and evolving societal demands, the four-dimensional collaborative mechanism for disseminating the spirit of scientific endeavor in libraries is poised to demonstrate diversified, intelligentized, and cross-domain cooperative development trends. First, cross-domain collaboration will emerge as a pivotal direction for this dissemination. As core institutions of knowledge dissemination, libraries will deepen partnerships with research institutes, educational institutions, and tech enterprises, forming a new multi-stakeholder collaborative model. For instance, collaborations with research organizations enable libraries to access cutting-edge scientific achievements and stories of scientists, thereby enriching content delivery. Partnerships with educational institutions allow tailored science education programs for students across different age groups [7]. Second, intelligent upgrades represent another crucial trend in library-based dissemination. Emerging technologies like artificial intelligence and big data will significantly enhance communication efficiency and precision. Through big data analytics, libraries can gain deeper insights into audience needs and preferences, enabling more personalized outreach strategies. Additionally, the integration of virtual reality (VR) and augmented reality (AR) technologies will provide immersive experiences that allow audiences to intuitively perceive the intellectual world of scientists [10]. Finally, shifting social demands will drive innovative developments in library-based science spirit dissemination. Against the backdrop of growing public scientific literacy, libraries need to transition from traditional one-way communication models to interactive, participatory approaches to strengthen audience engagement and sense of belonging. This transformation will not only improve the effect of communication, but also stimulate social innovation and promote the wide spread of science and culture.

9.2 Optimization suggestions are put forward

Although the four-dimensional collaborative mechanism for disseminating the spirit of scientists in library science has achieved initial success in theoretical construction and practical application, several challenges remain to be addressed. To optimize this approach, the following recommendations are proposed: First, strengthening cross-departmental collaboration is crucial for enhancing communication effectiveness. Library departments should establish closer cooperation mechanisms to ensure coordinated operations across four dimensions: resources, technology, services, and management. For instance, the literature resources department could collaborate with technical services to jointly develop a big data-driven platform for disseminating the spirit of scientists, thereby achieving efficient resource integration and technological support [1]. Second, improving technical capabilities serves as a vital guarantee for intelligent communication. Libraries should increase investment in emerging technologies and cultivate a professional workforce to adapt to rapidly evolving technological environments. For example, adopting artificial intelligence can enable smart recommendation systems and intelligent Q&A functions, thereby enhancing interactive engagement and targeted communication [5]. Third, refining incentive mechanisms proves effective in motivating staff. Libraries should establish scientific performance evaluation systems to recognize and reward

librarians who excel in disseminating the spirit of scientists, thereby stimulating collective enthusiasm and creativity. Additionally, building a comprehensive assessment framework is essential for optimizing communication strategies. Through data collection and analysis, libraries should regularly evaluate communication effectiveness and adjust strategies accordingly to ensure goal achievement [7].

9.3 Research deficiency and prospect

While this study has achieved certain results in exploring the four-dimensional collaborative mechanism for disseminating the spirit of scientists in libraries, there remain some limitations. First, regarding research methodology, this paper primarily employs literature review and case analysis without quantitative evaluation of actual communication effects. Future research could validate the practical application effects of the four-dimensional collaborative mechanism through methods such as questionnaire surveys and experimental studies [8]. Second, in terms of content coverage, the discussion on certain dimensions remains insufficient. For instance, within the technological dimension, the focus was limited to analyzing applications of big data and artificial intelligence technologies, while the potential application value of emerging technologies like blockchain and the Internet of Things received less exploration. Future research could expand the scope of technological dimension studies to explore more technical means for applying in disseminating the spirit of scientists [14]. Additionally, this study primarily focuses on internal collaborative mechanisms within libraries, with relatively limited attention paid to external cooperative networks. Future research could integrate social network theory to delve deeper into cooperation models between libraries and other institutions and their impact on communication effectiveness. In summary, research on the four-dimensional collaborative mechanism for disseminating the spirit of scientists in libraries remains in its infancy. Future studies should continue efforts in theoretical refinement and practical exploration, providing stronger theoretical support and practical guidance for libraries to play a greater role in scientific cultural inheritance [8][14].

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