Achieving "Precision Management" of Research Projects Under the New National Science and Technology Plan System: A Case Study of the Chinese Academy of Sciences Headquarters (Postprint)

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Abstract

Currently, China' s science and technology planning system and management model are undergoing substantial reforms, with scientific research management breaking down traditional "barriers" of fragmentation and compartmentalization to form a more efficient and authoritative decision-making, consulting, and management system. As the central organ of the Chinese Academy of Sciences (CAS), the CAS headquarters bears significant responsibilities for planning and managing various national and CAS projects. Consequently, in this new era, there is an urgent need to further enhance project management capabilities and standards to fully satisfy the new innovation requirements of research institutes and scientific personnel, and to adapt to the contemporary characteristics of interdisciplinary integration and collaborative innovation in science and technology. This article examines the new requirements imposed by China' s science and technology system reform on project management, analyzes emerging issues that warrant consideration, and proposes recommendations on implementing "precise management" of projects based on their specific needs, with the aim of stimulating further reflection and discussion among readers.

Full Text

How to Achieve Precise Management of Scientific Research Projects Under the New National S&T System—Taking the Administrative Offices of Chinese Academy of Sciences as Example

Abstract

China' s scientific research management system is currently undergoing significant reform, with traditional fragmented administrative structures being dismantled to establish a more efficient and authoritative decision-making, consultation, and management framework. As the central nervous system of the Chinese Academy of Sciences (CAS), the CAS headquarters bears critical responsibilities for planning and managing various national and CAS-level projects. Consequently, it must further enhance project management capabilities to meet the new demands of research institutes and scientists, while adapting to contemporary trends of interdisciplinary integration and collaborative innovation. This paper examines the new requirements imposed by China' s S&T system reform on project management, analyzes emerging challenges, and proposes recommendations for achieving "precise management" based on project needs, aiming to stimulate further reflection and discussion among readers.

Keywords: project management, management policy, reform of scientific research management, precise management

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In early 2015, the State Council issued the "Plan for Deepening Reform of Central Government Science and Technology Programs (Special Projects, Funds, etc.) Management," marking the official launch of comprehensive S&T system reform. The overarching objective is to strengthen top-level design, break administrative fragmentation, enhance functional division among departments, and establish a target-oriented, performance-based S&T program management system with Chinese characteristics. This new system focuses more sharply on national priorities, aligns better with innovation patterns, optimizes allocation of S&T resources, strengthens integration between science and economy, and maximally stimulates researchers' innovative enthusiasm.

Globally, the new S&T revolution has entered an era of "big science." The evolution cycle from "science" to "technology" to "market" has dramatically shortened, with faster technology updates and commercialization, and deep interdisciplinary integration becoming the general trend. Many research projects must break through established disciplinary boundaries, organizing scientists from diverse backgrounds to tackle major scientific questions or key technologies through coordinated efforts, leveraging multi-channel resources to achieve defined objectives [1,2]. Under this new S&T system and development trend, scientific research requires an open, collaborative, and competitive environment, which objectively demands higher capabilities and more sophisticated approaches to research project management.

New Characteristics of Research Project Layout

Multidisciplinary and Multi-domain Collaboration at the Professional Level. For instance, CAS launched the strategic pilot project "Key Technologies and Demonstration for Clean and Efficient Cascade Utilization of Low-Rank Coal" in 2012 [3,4], aiming to develop graded comprehensive utilization

technology with efficient pyrolysis as the precursor. However, coal pyrolysis is extremely complex, requiring in-depth research spanning basic studies, key technology breakthroughs, and system integration. This involves joint 攻关 by multiple disciplines including chemistry, chemical engineering, thermophysics, machinery, materials, and control systems. By coupling pyrolysis technology with combustion, gasification, indirect liquefaction, and other related technologies, the project formed a systematic solution for clean and efficient cascade utilization of low-rank coal. The project assembled a research team comprising over 500 permanent researchers and more than 400 visiting personnel from more than 10 CAS research institutes, covering all relevant disciplines and research fields.

Full-Chain Deployment and Integrated Implementation in Project Design. From an industrial demand perspective, project objectives must address "world S&T frontiers, national strategic needs, and economic development priorities." Consequently, project design requires full-chain deployment from basic research to applied research. Taking the Ministry of Science and Technology's "13th Five-Year" National Key R&D Program "New Energy Vehicles" as an example [5], the project tasks are divided into 4 levels and 12 modules. The four levels are: fundamental scientific questions, common core technologies, power system technologies, and integrated development and demonstration. The twelve modules comprise three scientific foundations—energy science, materials science, and information science; "three horizontal" common core technologies—batteries, motors, and electronic controls; "three vertical" power system technologies—pure electric, hybrid, and fuel cell power systems; and three supporting platforms—infrastructure platform, integrated demonstration platform, and international cooperation platform. The implementation plan for this key special project covers the complete S&T system and industrial chain of new energy vehicles.

Increasing Number of Enterprise-Led Projects. Applied research and technology development projects will increasingly be led by enterprises. Such projects may be solicited more from enterprises and industrial sectors, with evaluation criteria focusing on alignment with actual enterprise and market needs. Operationally, this may change the current model where enterprises and research units jointly apply for projects, allowing enterprises to independently apply for projects from government agencies. Government would only specify the proportion of funds allocated to research institutions, while strengthening subsequent supervision and acceptance. Research units would shift from selecting topics based on their own expertise and preferences—a practice that often led to misalignment between research directions and market demand—to actively monitoring industry and market needs, avoiding working in isolation.

Greater Emphasis on Business Model Innovation and Market Prospects. When enterprises participate in R&D programs, they consider whether new technologies can generate profits. However, for more forward-looking directions, enterprises and R&D units must innovate in business and operational models, fully leveraging respective advantages while sharing risks

and benefits, to keep pace with the global S&T revolution. For example, CAS' s Zhongke Nanxin Printing Technology Co., Ltd. developed nano-printing technology. Since large-scale application of this technology might disrupt existing business models in the printing industry and impact the current plate-making industrial chain, causing redistribution of commercial interests, innovative approaches are needed for technology promotion, such as establishing "dry-cleaning store" model green printing plate-making platforms in areas with concentrated small and medium-sized printing enterprises to provide plate-making services.

"Focus on Both Ends with Emphasis on Coordination" in Project Management. As national S&T system and public institution reforms deepen, specialized agencies for socialized and market-based project management and funding supervision are maturing. CAS headquarters should gradually rely on these specialized agencies for process management of national projects. CAS headquarters should shift its management focus to "grasp both ends and emphasize coordination," paying more attention to top-level design and post-evaluation and industrialization services after project completion, strengthening overall coordination and effective linkage among S&T, economic, and social policies to accelerate and amplify the translation of research results into real-world impact.

New Requirements for Research Project Management

Project Management Must Focus on Industry Needs, Strengthening "Promotion" and "Marketing." For a considerable period, the connection between CAS' s research work and industry needs has not received sufficient attention. Research direction selection was primarily determined by frontline scientists based on their judgment of S&T development trends and global competition, often leading to misalignment with market demand from the project initiation stage and resulting in a low proportion of results with transformation value [7]. According to the new characteristics of China' s research system and CAS' s new mission of "facing world S&T frontiers, facing national strategic needs, and facing economic development priorities," future research at CAS will intersect and integrate with broader industry sectors. This requires research managers to have the sharpest perception of technological change and market demand, guiding project positioning from a "marketing" and "sales" perspective, innovating resource allocation models to respond to market demand quickly and strengthen top-level design for transformation models.

As CAS' s nerve center, the headquarters' nature determines that specific project management personnel should possess greater strategic vision and broader industrial perspective, requiring them to have "promotion" and "marketing" capabilities to guide project layout and industrialization of project outcomes. In fact, CAS project outcomes and research teams are themselves our "products" that need to be actively "taken out" to conduct industry surveys, collect market information, establish databases of key industry technology needs, and build communication platforms with key industries and enterprises. Additionally,

they must provide necessary support for institutes encountering difficulties in industrializing results, including legal, intellectual property, cooperation models, and negotiation skills, offering more professional customized consulting services. Therefore, agency project managers, in addition to their supervisory role, must increasingly serve as professional high-quality personnel providing consultation, intellectual property protection, and market promotion services for technology transfer.

Project Management Process Needs Further "Decentralization, Regulation, and Service." Traditionally, CAS headquarters, as the project funder and supervisory department, organized project initiation demonstration, process inspection, mid-term review, and acceptance, with project undertaking units as the "managed" party, "supervised" together with project completion teams. Facing current new characteristics of research layout, CAS headquarters should proactively implement "decentralization, regulation, and service": delegate work that undertaking units can perform, manage system construction well, and enhance the agency' s in-depth "service" capabilities. CAS headquarters should clarify admission criteria for project initiation, grasp overall layout, and establish assessable project objectives, delegating specific management procedures such as process management, certain budget adjustments, and project technical route modifications to project undertaking units for supervision and completion. Under clear management norms, granting certain decision-making power to management departments of undertaking units can enhance their participation in the overall project process and improve overall management efficiency. CAS headquarters can focus its work on connecting projects with national and local planning, planning project extension and results amplification, fully playing the important role as the central nervous system.

Project Management Team Division Needs Repositioning. In recent years, although most Chinese research institutions have undergone various reforms, their management work still largely adopts "linear" or "hierarchical structure" models. This model emphasizes professional division and hierarchical division, with each member responsible for part of the work and reporting to higher-level leaders. Cross-departmental collaboration, even when it occurs, mostly remains at a shallow level, rarely achieving deep integration. While this linear structure has clear authority and responsibility, unified command, simple information communication, and extremely high execution efficiency in certain situations, its shortcomings—lack of flexibility and insufficient professional specificity—have become increasingly apparent under the big science innovation trend, as management complexity and requirements for refined management continue to increase. Particularly in work requiring deep domain involvement, differences in direct managers' work experience and professional fields may affect management effectiveness and efficiency. Therefore, we need to break original professional divisions and build a more adaptable management system.

Project Support Methods Need Greater Diversification. Traditional project support generally means financial support, which is also the most im-

portant content of agency project management. Facing rapidly evolving S&T progress and capital market promotion of S&T achievements, research projects' required support is not necessarily financial. Their smooth implementation also needs more diversified support in policy, personnel, and supporting facilities. For some research projects with high market attention, research teams may already receive strong financial support from social and local channels, but what they lack might be promotion at the CAS level, or policy support, personnel support, and supporting facility support in implementation regions. Relying solely on research teams to push these matters they are not good at would likely produce half the results with double the effort. CAS headquarters should provide corresponding support in staffing, policy guidance, start-up funding, platform construction, and external liaison according to different project stages and R&D activities, offering more soft services through various channels to pave the way for smooth project implementation and accelerate successful project completion.

Project Outcomes Need to Reflect Project Managers' Contributions. Under the new normal, project management should be multi-directional, high-level, and deeply involved. If project outcomes do not reflect the contributions of project managers working behind the scenes, it would be difficult to maximize their motivation and initiative. In traditional project management processes, project managers' roles were often singular during project initiation, inspection, and acceptance, failing to reflect customized in-depth services provided according to real project needs. Under the new management system, we could consider incorporating the customized services that project management teams can provide directly into project task statements, clarifying what necessary services and support the project management team will provide for project execution, assigning responsibilities for difficulties and challenges from the beginning, and implementing step by step.

Thoughts on Implementing "Precise Management" of Research Projects

Currently, CAS is deeply implementing the "Pioneer Initiative" plan, actively promoting institutional classification reform, accelerating construction of new R&D institutions, and forming management models conducive to S&T achievement transformation. Under this new institutional management model, project support methods may adjust according to different R&D stages, requiring exploration of new project management models that fully leverage each project manager' s strengths.

Establishing Project Director System. In many foreign national research project management systems, institutions have established positions similar to "project manager" or "project director" to represent departments in executing management responsibilities. For example, NASA' s project management manual specifies responsibilities of management officials at all levels for monitoring, decision-making, and execution of projects/sub-projects [8]. NASA divisions (similar to CAS professional bureaus) appoint or approve "program directors"

jointly with the president, who then appoint several "sub-project managers" with approval from division directors. Program directors are responsible for project implementation from selection to final product delivery, including project integration, monitoring, and support for sub-projects. Program directors and sub-project managers mutually support each other through full authorization and good communication, which are key to project success. In NSF and DOE project management, program directors are also established and publicly recruited. They represent national departments in specific project management, forming integrated project teams with contract party (乙方) project leaders to jointly advance project progress [9,10].

Based on these latest characteristics of project management in China, to clarify responsible entities and ensure clear responsibilities and proper roles, we can learn from foreign project manager systems with improvements to form our own characteristic management system. CAS headquarters can establish different project management teams as needed, setting up project director roles to represent CAS headquarters in project supervision, management, and provision of supporting services to adapt to new normal requirements for project management.

In project management teams, the "project director" has authority to mobilize all resources, is the actual leader and organizer for achieving project goals, while other participants can be defined as "project specialists." Project directors need to exert macro-level management and coordination capabilities, while project specialists need to fully develop execution capabilities. Each management team member can simultaneously serve as both "project director" and "project specialist" roles, thereby establishing an effective collaboration mechanism across the team (Figure 1 [Figure 1: see original paper]).

Specifically, the "project director" role involves macro management and coordination, developing project schedules, and dividing abstract management work into executable and assessable modules. Project directors then assign these modules to project specialists based on their expertise for implementation, such as conducting research, data analysis, process management, and information collection. Project specialists' work results are aggregated by project directors and shared with project teams. In this process, project specialists become deeply involved in project directors' work, learning more knowledge and meeting more people, while project directors share the fruits of their labor. Correspondingly, in other project management teams, the "project director" role can transform into a "project specialist" for others, completing various execution-level tasks as required by other project directors. Thus, everyone serves as project director for some projects while being project specialist for others.

The greatest advantage of the "project director" and "project management team" approach is its relative flexibility, effectively compensating for project managers' professional limitations and limited energy, fully utilizing each individual' s strengths, and integrating relevant forces to provide assistance and services for project organization and implementation according to different project

characteristics and needs. This approach maintains the original functional system without personnel changes, ensuring organizational stability while maximizing member potential and fostering healthy competition, conducive to member rapid growth.

Establishing Dual Performance Evaluation and Incentive Mechanism. How to evaluate project management personnel has long been a concern for research institutions, with the difficulty lying in establishing evaluation metrics. Many evaluation innovations in similar organizations remain at the level of supervisor evaluation, peer evaluation, and client evaluation, with varying effectiveness. To achieve "precise management" in CAS headquarters' project management, each manager or management team must fully exert subjective initiative, proactively providing more in-depth services for project implementation and follow-up services. The main driver for mobilizing management personnel' s enthusiasm comes from establishing reasonable incentive mechanisms.

Through investigation, corporate management evaluation systems mostly implement evaluation through "Key Performance Indicators" (KPI). The KPI evaluation method decomposes strategic objectives into operational work targets, cascading from top to bottom to every employee. Established indicators must be assessable, whether economic, quantitative, or milestone indicators. This corporate KPI system makes annual work objectives concrete, improving overall team efficiency. CAS headquarters' daily work is relatively complex, with each department, division, and even individual handling many unexpected tasks that occupy substantial time. Since these unexpected tasks are difficult to anticipate, quantifying evaluation metrics becomes challenging.

Given the work characteristics of CAS headquarters' project management departments, we can consider a dual evaluation system (Figure 2 [Figure 2: see original paper]), dividing work objectives into passive work ("mandatory tasks") evaluation and active work ("discretionary tasks") evaluation. Passive work evaluation focuses on completing assigned duties and sudden tasks assigned by leaders, such as project refinement and inspection, with quantitative or semi-quantitative assessment by each employee' s immediate supervisor. Active work evaluation involves employees setting their own annual work objectives based on project characteristics to achieve precise vertical management, such as completing certain industry-enterprise connections, achieving specific project landing rates, or meeting quantitative indicators like S&T input-output ratio, research achievement transformation rate, and industry-academia-research integration degree. For active work indicator setting, quantification or semi-quantification is needed as much as possible, which may be relatively complex and require careful consideration by employees and discussion with colleagues and leaders before finalization. During this process, employees have relatively high autonomy, while leaders play a supervisory role to prevent overly aggressive or conservative targets. After indicators are established, benchmarking evaluations are conducted semi-annually to timely identify gaps and deficiencies, facilitating positive project development.

This dual evaluation approach encourages each department or manager to provide "precise management" and customized vertical services for responsible projects, stimulating subjective initiative of teams and individuals, helping improve professional competence and management levels of individuals and entire management teams.

Establishing Intra-Institute Department Linkage System. Under the new S&T program system, research projects tend toward diversity and openness, requiring support far beyond single funding methods. If support in human resources, materials, and finances can be synergistically optimized and integrated, proactively adapting to new project needs and customizing project management and support methods, project implementation can be greatly accelerated, attracting more social resources and promoting projects into virtuous cycles for sustainable development.

To truly achieve coordinated linkage of various resources, we need to institutionally stimulate the advantages of "project directors" and "project management teams," allowing "project management teams" to be formed according to different project needs, thereby fully mobilizing resource advantages of each member to form a linkage system. Simultaneously, from the overall CAS planning perspective, we must emphasize resource linkage proportions, establishing resource guarantees for the linkage system from the root and implementing step by step according to planning.

Establishing Post-Project Evaluation System. Strictly speaking, "post-evaluation" should be comprehensive evaluation conducted by third parties on projects or programs after completion for a period of time. In this case, project or program supervisors and implementers are evaluated as a whole. For example, the U.S. NSF must conduct annual performance evaluation of its project funding performance (not individual projects) according to the Government Performance and Results Act (GPRA) and release it to the public [11]. Against the backdrop of China' s not-yet-mature post-evaluation system for research funding, CAS can conduct self-evaluation of established projects after completion. Through self-evaluation, we can track and understand subsequent development needs of related work at institutes to provide continuous support for important work.

Evaluation requires comparison, and post-project evaluation should be combined with planning formulation. Only by integrating CAS's long-term strategic planning, annual planning, and post-project evaluation, and conducting evaluation based on quantitative and qualitative objectives established in planning, can post-evaluation become more operational. Furthermore, establishing an institutionalized post-evaluation system requires massive data accumulation. Data on project-level relevant results are necessary foundations for post-evaluation of programs and more macro-level projects. China still has deficiencies in accumulation and acquisition of basic scientific research achievement data, requiring further standardization of data collection and certification at national and institutional levels, and promotion of data sharing to lay a reliable foundation for scientific research management and decision-making, including post-project

evaluation.

Establishing Sound Post-Project Funding Mechanism. Currently, CAS Bureau of Science and Technology for Development is exploring implementation of post-project funding for technology transfer projects. This approach can greatly stimulate enthusiasm of project undertaking units to solicit social resources, while helping relevant units and personnel cooperate closely around project tasks, improving funding efficiency, promoting construction of industry-academia-research alliances and deep cooperation, and facilitating transformation of CAS S&T achievements into real productive forces and drivers for national strategic objectives.

The post-project funding approach has certain advantages but also requires attention to some issues. Adopting post-project funding requires undertaking units to have substantial self-owned financial support. Therefore, for some high-risk, early-stage research projects requiring large investment, implementation may be difficult due to lack of support from undertaking units. CAS headquarters should timely summarize experience in post-project funding work, listen to opinions and suggestions from undertaking units, researchers, and relevant experts, and further standardize the scope of post-project funding support and funding accounting methods. Additionally, we can encourage institutes to voluntarily choose post-project funding proportions, with larger proportions receiving greater total project funding support, amplifying post-project funding effects through "leveraging small amounts to move large amounts."

Conclusion

Improving scientific research project management cannot be separated from the efforts of managers themselves and support from all quarters. Under the backdrop of national S&T system reform, every project manager should re-examine their role, strive to improve understanding of modern project management concepts, build a professional management team that prioritizes service, leverages individual strengths, and cooperates closely, becoming the backbone for implementing CAS' s "Pioneer Initiative" plan.

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7. [Note: Reference 7 appears to be missing from the original list]

8. [Note: Reference 8 appears to be missing from the original list]

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11. [Note: Reference 11 appears to be missing from the original list]

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