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Services and Support of Big Data Technology Empowering Science and Technology Management

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Abstract: At present, scientific and technological innovation activities are becoming increasingly complex and data-intensive. Traditional science and technology management approaches face increasing challenges in addressing the growing complexity and data-intensive nature of innovation activities. The emergence and application of big data technology have provided new tools and new thinking for science and technology management, and its rich functions can effectively support science and technology management. Based on the actual needs of science and technology management, this paper analyzes the service functions and supporting roles of big data technology in many fields, such as optimal allocation of scientific and technological resources and whole-process supervision of scientific research projects, and puts forward implementation paths to improve the level of science and technology management.

Keywords: Big data technology; Science and technology management; Service; Support

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1. Introduction

Science and technology management refers to a series of activities for organizing, coordinating, controlling, and evaluating scientific research, technological development, and related efforts, aiming to continuously improve the utilization efficiency of scientific and technological resources and to ensure the achievements of scientific and technological innovation. In recent years, the scale of scientific research activities has been expanding, and scientific research data has shown a sharp increase. The information environment for science and technology management has changed dramatically compared with the past, mainly reflected in the number of scientific research projects, the forms of scientific research output, and the relationships among scientific research entities. The surging quantity, increasingly diverse forms, and increasingly complex relationships have put forward new requirements for science and technology management: it can neither adopt simple statistical methods nor rely on manual experience [1]. Big data technology has unique advantages in data collection and storage, which are conducive to solving the problems in science and technology management.

Therefore, we should give full play to the service and supporting functions of this technology to promote science and technology management to a new stage of development.

2. Service functions of big data technology in the allocation of scientific and technological resources

2.1. Construction and precise matching of scientific and technological talent portraits

The efficiency of science and technology management is closely related to the rapid identification of talent resources. Traditional talent evaluation methods are relatively single, mainly relying on explicit indicators such as papers and awards, which cannot comprehensively measure the actual ability and development potential of scientific researchers. Big data technology can integrate talent information from different channels, such as educational background and project undertaking. Through the integration of heterogeneous data, coupled with data cleaning, feature extraction and other activities, it is conducive to building a three-dimensional scientific and technological talent portrait. In addition to the research direction and output quantity of scientific researchers, this portrait can also reveal their cooperation network and the evolution track of research interests. Science and technology managers can use this portrait to realize supply-demand matching in multiple scenarios, mainly referring to project review and team formation scenarios [2]. For example, for major project approval, the system can automatically screen researchers and their collaborators according to the consistency with the research direction of the project, provide their performance in previous studies, and avoid blind decision-making through quantitative evaluation of performance. To realize this function, it is necessary to continuously update the massive talent database and constantly optimize the model, build scientific and technological talent portraits by establishing unified data standards and sharing mechanisms, and realize the precise matching of both supply and demand [3].

2.2. Intelligent scheduling for the sharing of scientific research facilities and instruments

Scientific and technological innovation requires large-scale scientific research instruments and experimental platforms, but having only these is not a material basis. If the allocation is unbalanced and efficiency is not emphasized, innovative achievements will be castles in the air. The emergence and application of big data technology are conducive to solving this dilemma. Starting from scientific research facilities, deploying IoT sensors and data collection terminals can obtain real-time equipment-related information, such as usage status and operating hours. After collecting these data on a unified cloud platform, big data analysis technology is used to identify and analyze the usage rules of equipment in different time periods, regions, and disciplines, and then predict future usage demand and idle periods [4]. Combined with the analysis results, science and technology managers can formulate a more complete and scientific equipment scheduling plan. During idle periods, external units can use the equipment, and the equipment utilization rate can be improved through equipment reservation. At the same time, the big data platform can also record the equipment usage in detail, providing data support for subsequent cost accounting and maintenance. In addition, by analyzing the relationship between equipment usage data and scientific research output data, large-scale instruments can be evaluated for their role in scientific and technological innovation, avoiding blind equipment procurement decisions, having a scientific basis, bidding farewell to repeated procurement, and avoiding resource waste [5].

2.3. Dynamic optimization of scientific research funding allocation

The most complex and sensitive link in science and technology management is how to allocate scientific

research funds. Traditional funding allocation mainly adopts the historical base method and the peer review method, both of which have advantages and disadvantages. For example, the former is easy to form path dependence on funding allocation, and the latter is easily affected by the subjectivity of reviewers [6]. The application of big data technology can provide decision support for funding allocation.

Firstly, through a comprehensive analysis of the efficiency of project funding use, such as output indicators of papers and patents generated by unit funding, a benchmark model of funding input and output is established, which includes different disciplinary fields and different types of projects. Secondly, natural language processing technology is used to analyze the relevant text information in project applications and progress reports, extract features such as the innovation degree of research content and the feasibility of technical routes, compare with historical successful projects, and assist in judging project quality through similarity comparison. Finally, the implementation process of funds is monitored in real time to understand the expenditure data, and abnormal behaviors such as abnormal progress of fund use are found in time, thus triggering an early warning mechanism [7]. This allocation model based on big data makes the flow of funds more scientific and reasonable through dynamic optimization. Research teams with strong innovation potential and execution ability can often obtain corresponding funds, improving the efficiency and benefit of the use of public financial funds.

3. Supporting role of big data technology in the whole-process supervision of scientific research projects

3.1. Feasibility assessment in the project approval stage

The approval decision of scientific research projects is crucial, directly affecting the investment direction of scientific and technological resources and the effectiveness of scientific research activities. Traditional approval review mainly adopts the expert scoring method, and the review results are easily affected by expert preferences and knowledge limitations. Big data technology can avoid blind approval decisions and improve their scientificity by providing feasibility analysis reports before review [8]. Through the analysis of relevant databases, the knowledge map and technology maturity curve of the research direction are drawn to identify the research direction and sub-fields. At the same time, text mining technology is used to detect the innovation points of project applications, compare with existing research results, and judge the innovation value [9]. In addition, analyze the historical cooperation network and output data of the application team to evaluate their collaboration and resource integration abilities to complete the project. Experts can make full use of these analysis results during review to improve the scientificity of their decisions. The value of big data technology at this stage is mainly reflected in the combination of qualitative judgment and quantitative analysis, greatly reducing decision-making risks.

3.2. Dynamic monitoring of the project implementation process

For the implementation of scientific research projects, managers should comprehensively and promptly grasp project progress to respond effectively when problems arise, including early intervention and timely adjustments. The traditional method of regularly submitting progress reports not only suffers from information lag but also content distortion. Big data technology can dynamically monitor and issue intelligent warnings throughout the project implementation process. Through the data interfaces of scientific research project management systems and various business systems, relevant project data can be automatically collected, such as detailed fund expenditures and experimental data records. With the help of data visualization technology,

managers can view this information in the form of dashboards and intuitively grasp the project status. In addition, by building a project risk prediction model that compares current project data characteristics with the characteristic patterns of historical failed projects, the model can identify projects at risk of delays and overspending. For projects with such risks, early warning information is automatically sent to managers and project leaders. This dynamic monitoring mechanism helps overcome the drawbacks of traditional management, making it no longer passive but proactive in finding problems and taking intervention measures in a timely manner, which is an important way to reduce the probability of project failure [10].

3.3. Objective evaluation of project completion acceptance

To test the effectiveness of scientific research activities, it is necessary to accept the completion of the project. Whether the evaluation results are fair and accurate has an important impact on the enthusiasm of scientific researchers and subsequent resource allocation. Traditional completion acceptance mainly adopts the expert group evaluation method, which is time-consuming and has subjective deviations. Big data technology can build a multi-dimensional completion evaluation model, which is conducive to improving the efficiency of acceptance work and making it more objective. On the one hand, automatically collect the output data during project execution, such as paper citation frequency and patent transformation, and calculate the project score based on the preset indicator weight. On the other hand, use text similarity analysis technology to automatically compare the research results in the project result report with the expected goals in the project application to evaluate the goal achievement. In addition, analyze the network relationship of project results cited by subsequent studies to measure their impact in the academic community. The application of big data technology in the completion acceptance stage not only provides quantitative evaluation results but also precipitates evaluation process data. Optimizing project review standards and funding allocation models helps form a virtuous cycle of science and technology management.

4. Supporting paths of big data technology in the evaluation and transformation of scientific and technological achievements

4.1. Construction of a multi-dimensional value evaluation system for scientific and technological achievements

The core business of science and technology management includes the evaluation of scientific and technological achievements. Whether the evaluation results are scientific and fair has an important impact on the research orientation. Traditional achievement evaluation emphasizes the impact factor and citation frequency of papers, ignoring other values of achievements, such as social value, economic value and potential application value. Big data technology has provided technical support for the construction of a multi-dimensional achievement value evaluation system. Through the integration of multi-source data such as academic and patent databases, news media and social networks, project achievements can be comprehensively evaluated from the dimensions of academic influence and technological innovation. To understand the social influence and industrial value of an achievement, we can start by analyzing its discussion heat on social media and submission frequency in policy documents. At the same time, text mining technology is used to extract technical features, analyze the matching degree with existing technologies and market demand, and then predict the possibility and time window of its transformation into practical applications. Such an evaluation system is conducive to guiding scientific researchers to focus on the diversified value of achievements instead of simply pursuing the number of papers, realizing a substantial change in

the orientation of scientific and technological evaluation.

4.2. Intelligent matching of technology supply and demand

The ultimate goal of science and technology management is to transform scientific and technological achievements into real productive forces. However, information asymmetry between technology suppliers and demanders leads to many achievements that are unable to get out of the laboratory. Big data technology promotes the docking of technology supply and demand by building an intelligent matching platform, which reduces the cost of information search and collection and helps improve docking efficiency. To build this platform, relevant workers first need to establish databases, mainly referring to standardized technology achievement databases and enterprise technology demand databases. For technical achievements, focus on extracting keywords and function descriptions from patent specifications, technical reports and other documents to build result portraits; for enterprise needs, analyze public technical bidding information and industry reports, and refine the technical pain points and specific demand directions faced by enterprises. On this basis, collaborative filtering and content-based recommendation algorithms are used to match technical achievements with potential needs and sort and push them based on the matching degree. In addition, the platform can also record user data, such as browsing and collection during the docking process, and optimize the recommendation algorithm by analyzing these behaviors. In short, the intelligent matching platform is conducive to shortening the search time for both technical parties, improving the success rate of scientific and technological achievement transformation, allowing science and technology management to gradually extend from previous achievement statistics to achievement application, and helping to realize its full-chain service.

4.3. Big data early warning of risks in the transformation of scientific and technological achievements

The transformation process of scientific and technological achievements is not only long-cycle but also high-risk, involving many uncertain factors such as technological maturity and market acceptance. Science and technology management departments should start with the transformation process, identify and warn risks, and lay a foundation for subsequent response measures. Big data technology can build an early warning system based on the risks of scientific and technological achievement transformation. This system integrates multi-dimensional data such as market and technology. Among them, the technical dimension includes the patent protection intensity, technical competition situation and technical iteration speed of achievements; the market dimension includes elements such as potential market size and competitor trends; the policy dimension mainly focuses on industrial policies, intellectual property laws and regulations; the financial dimension involves the attention of investment institutions and the looseness of the financing environment. On this basis, a risk assessment model is constructed to score transformation projects dynamically. Once the comprehensive risk score is abnormal, an early warning will be automatically triggered. In addition to analyzing the source of risks, the early warning information also includes possible consequences and recommended measures. Such a risk early warning mechanism has changed the response mode of science and technology managers from passive response to active prevention and control, which not only improves the success rate of scientific and technological achievement transformation but also helps reduce the risk of state-owned asset loss.

5. Conclusion

In short, big data technology has promoted the modernization of science and technology management. Whether it is the optimal allocation of scientific and technological resources, the whole-process supervision of scientific research projects, or the evaluation and transformation of scientific and technological achievements, big data plays an important role in many links. However, when big data empowers science and technology management, there are still many drawbacks, such as data silos and privacy protection concerns. In the future, we should improve the scientific and technological data governance system, establish a data sharing mechanism, and cultivate interdisciplinary and innovative talents who are skilled in both science and technology management and big data analysis. At the same time, we should strengthen algorithm transparency and improve data security protection, so that the application of big data technology in the field of science and technology management is healthier and more orderly, and science and technology management is no longer driven by experience but by data.

Disclosure statement

The authors declare no conflict of interest.

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