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An empowerment evaluation framework for national scientific and technical information governance①

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Abstract

'Empowerment' is the result of pursuing special capabilities under a specific value orientation. The changes in related object capabilities triggered by scientific and technical information activities in the new environment are important to the national scientific and technical (S&T) information governance. Based on the empowerment theories and evaluation practices, this study attempts to construct an empowerment evaluation framework for national S&T information governance and takes the participatory technology assessment and Altmetrics methods as examples to demonstrate its advantages: 1) The capability changes and development potential are regarded as important basis for evaluation; 2) The multi-person participation and multi-indicator comprehensive evaluation method is conducive to the democratic and objective nature of science and technology information governance policy formulation.

Key words: scientific and technical (S&T) information governance, empowerment evaluation, technology assessment, EE-capability system

0 Introduction

National scientific and technical (S&T) information governance solves the problem of incomplete information in the government decision-making process by rationalizing and optimizing the management of the information enterprises, and plays a non-negligible role in the formulation and implementation of the national strategy of innovation-driven development in China. In 1956, Premier Zhou instructed the inclusion of S&T information in 57 major items of the National Science and Technology Development Vision of 1956 – 1967, and established its position in S&T development[1]. Then, it has played an important role in the developments of China's science and technology, education and national defense construction. Since the beginning of the 21st century, international situation and information environment have been changing and China's S&T information enterprises have been facing unprecedented challenges[2]. Firstly, the implementation of the overall national security view in China requires S&T information institutions to give more consideration to balance national security and development, improve the level of their productions, and pay more attention to technology strategic foresights and security assurances. Secondly, in the context of big data, it is required to give theoretical supports for institution-building and personnel training to narrow the gap between perception and cognition in order to fulfill the tasks of construction and using data infrastructure. With the scientific evaluation methods based on bibliometrics being overemphasized in the field of science and education management in China, indicators have become keys in evaluating the professional performances of researchers. However, the activities related to documents have become the main tasks of information institutions, for example, document service, document retrieval, document organization and measurement, resulting in the shift of the focus of information work[3].

With the development of big data, the word 'empowerment' has entered the Internet field, and has links with 'Internet +', 'enterprise platform' and 'intelligent manufacturing' to promote empowerment, creativity and vitality. In enterprise management areas, 'empowerment' is closely related to human resource management, total quality management and so on. It is regarded as one of the effective means to encourage employees to innovation and learn. In the practice of information management, 'empowerment' is often

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mentioned not only as a simple way to give abilities, but as an important concept contained in S&T information governance.

1 Related work

1.1 The concept of empowerment evaluation

The term 'empowerment' began to enter the field of scholarship in 1980s. Initially, Julian Rappaport, a social psychologist defined it as the process of acquiring abilities by individuals, organizations, or groups[4]. Empowerment has been a construction that links individual strengths and competencies, natural helping systems, and proactive behaviors to social policy and social change[5]. It may include measures such as joint participation of others, efforts to obtain resource authority, and interpretation of the social and political environment and lead to enhance competitive advantages. A number of studies have been developed on the basis of this definition. For example, Cornell Empowerment Group regarded empowerment as the core position of the organization. By empowering, the situation that high-value resources can't be shared equally can be changed, so that each member of the organization can fully enjoy the use and control of resources[6].

Empowerment has been used in many subject areas and can be involved at individual, organizational, and group levels. Researchers often understand its concept based on specific research questions and methods. Although its term definitions are numerous and associated with specific operations, and lack a unified and universally defined form, in general, empowerment is a concept associated with ability enhancement, self-improvement, environment perception, early warning and other behaviors[7]. As a value orientation, empowerment focuses on ability identification rather than listing risks, emphasizing professionalism and synergy rather than blindly following expert authority. The empowerment-oriented method has advocated the improvement of the overall ecosystem health while solving problems and provided participants with the opportunity to learn and improve their skills[8].

Empowerment evaluation was originally proposed by David Fetterman in the 1993 Annual Meeting of the American Evaluation Association (AEA)[9], emphasizing the use of evaluation concepts and techniques to foster abilities[10]. Founded in 1986, the American Evaluation Association is a professional organization composed of relevant personnel who are dedicated to the exploration and application of various evaluation forms such as scientific evaluation and project evaluation. In 2005, AEA held a symposium on 'Empowerment Evaluation and Traditional Evaluation: 10 Years Later'. In the conference articles, Cousin[11] believed that the concept of current empowerment evaluation was still somewhat vague. Fetterman and Wandersman[12] defined empowerment evaluation as an assessment method that aimed to increase the likelihood of project success, and needed to provide stakeholders with project planning and implementation evaluation tools. Miller and Campbell[13] collected and analyzed 47 cases of empowerment evaluation from 1994 to 2005, and found that the actual operation methods were more diverse and the project beneficiary results were insufficiently valued. Smith[14] believed that the empowerment evaluation was still at the stage of concept, and a unified method had not yet been formed, which needed further development.

1.2 The practice of empowerment evaluation

The concept of empowerment evaluation has been of concern to researchers in many evaluation fields. It also has attracted attention gradually in information organizations and technology assessment institutions. Some important representative institutions in the field of strategic intelligence analysis are closely related to the empowerment evaluation.

The United States Department of Defense's Office of Net Assessment (ONA) was created in 1973 to serve as the Pentagon's 'internal think tank'. It plays an important role in the formulation of the US national security strategy, defense strategy, and military strategy. On December 23rd, 2009, the US Department of Defense issued DoD Directive 51111.11, entitled 'Director of Net Assessment'[15]. It redefined the net assessment as a kind of methods to make comparative analysis on the military, technical, political, economic, and other relevant factors that determine the country's military capabilities. Net assessment deals with problems from some special perspectives, by which the areas and ways can be found to improve key capabilities and skills. Furthermore, large-scale difficult problems can be disassembled into multiple operational problems and solved through skills development[16]. Based on the net assessment theories, ONA identifies and predicts the opportunities and threats that the United States will face in the future by evaluating and comparing the military capabilities and potentials of both competitors and the enemy[17], thus providing a basis for US strategic decision-making.

With the development of the concept of empowerment evaluation, the S&T assessment institutions have gradually changed. By observing the changes in these

institutions, the tasks and targets of empowerment evaluation can be recognized more clearly.

The Office of Technology Assessment (OTA) had helped the US Congress and national agencies make the right judgments by submitting rigorous, diverse, and valuable assessment reports. However, the OTA approach still has certain limitations[18], including slow delivery of intelligence products, deification and blind obedience of authoritative assessment reports, lacking of innovation on the product reporting, neglecting the role of technology in social relations and political structure, ignoring the interrelated effects of a variety of seemingly unrelated factors, ignoring the complex effects of social technology drivers, having difficulties to break through static and isolated islands, lacking of public perspective and so on. After the OTA stopped working, its original S&T evaluation functions were mainly dispersed in the Congressional Research Service (CRS), the Government Accountability Office (GAO), and the National Academy of Sciences/National Research Council (NAS/NRC)[19]. The CRS can provide Congress with a concise and timely abstract of S&T policies, and the NAS/NRC can conduct in-depth analysis of S&T policy issues. Since 2007, the Congress has established a permanent technology evaluation function within the GAO, which has been authorized by Congress to initiate appropriate technology assessment based on their needs.

The new evaluation mechanism made up for the OTA's shortcomings with collaborative participation, played an important role in decision-making, and promoted the development of the US S&T evaluation system.

In China, the S&T information career is facing changes in 3 strategic environments: the first is the gradual change of the country's political and economic order by emerging market countries represented by China; the second is a leap-forward revolution in the production and life of human society by new technologies represented by the Internet; the third is the in-depth construction of China's national security governance system under the guidance of the overall national security concept[20]. With the transformation of the strategic environment and the full implementation strategies of the national innovation-driven development and strengthening the country through science and technology, China must lead the world in the field of major scientific and technological innovation. Then the S&T information departments will assume the role of 'national information system builder' to take on the important functions of integrating the R&D power of S&T information from all walks of life[21]. The national S&T information governance follows the general law of modern state governance. The change from management to governance requires the broad participation of multiple subjects, and the rational distribution of power is achieved through the empowerment of them.

2 Proposed empowerment evaluation framework

2.1 EE capability system

'Empowerment' is the result of pursuing special capabilities under a specific value orientation, which will inevitably bring about changes in the capabilities of related objects. The empowerment evaluation in national scientific and technical information governance is the evaluation of the changes in related objects' capabilities caused by scientific and technical information activities under specific value orientations. These capabilities mainly include information, competitiveness, decision-making and innovation, and are ultimately manifested by changes in influence (Fig. 1).

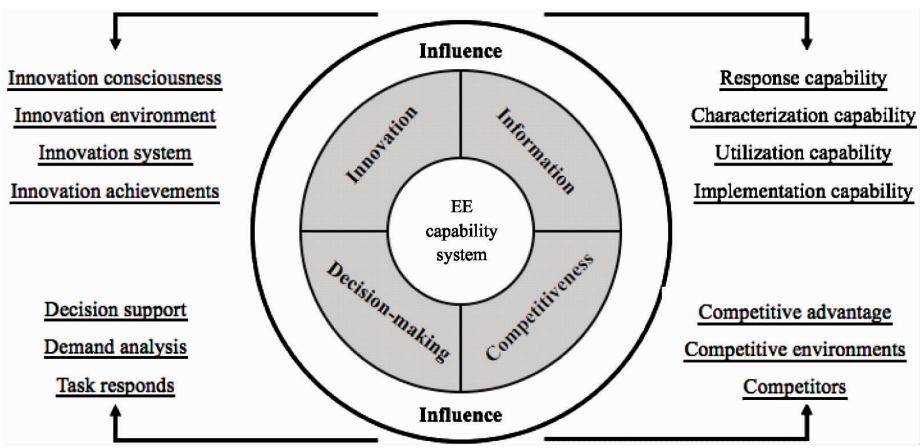

Fig. 1 EE capability system

1) Information capability

At present, the discussion on information capability is mainly divided into 2 aspects. In a narrow sense, the information capability mainly refers to the ability of people, organizations or institutions to implement action plans in the information process; in a broad sense, it refers to the ability of relevant information objects to conduct activities around information. The information objects here include not only information producers but also information consumers. Activities around information include not only information processing, but also the use of information. In empowerment evaluation, the evaluation of information capabilities is mainly based on indicators such as information response capability, characterization capability, utilization capability, and implementation capability.

2) Competitive capability

Competition is the intrinsic property of intelligence, and the improvement of competitiveness is the most direct result of intelligence empowerment. Competitive intelligence processes, analyzes and evaluates information about competitive environments and competitors in order to obtain and maintain competitive advantage, thereby providing a basis for the formulation of competitive strategies and strategic decisions. Competitive capability is the competitive advantage brought by competitive intelligence products.

3) Decision-making capability

The incomplete information problem related to science and technology in the process of national governance decision-making needs to be solved through S&T information work. Information experts provide support and evidence for decision-making, characterization and response to S&T information needs, objects and tasks, thus leading to the improvement of decision-making capability.

4) Innovation capability

Under the background of the National Innovation-driven Development Strategy in China, S&T information needs to play its due role and effectively provide support and guarantee for the country's various S&T innovation activities. Innovation is first reflected in the novelty and uniqueness. It needs to have a good grasp of the status quo and future trends of science and technology development, in order to achieve early warning and prejudice, occupy the forefront of technology, and grasp the opportunities for innovation. The ability to innovate is mainly reflected in the aspects of innovation awareness, innovation environment, innovation system and innovation achievements.

2.2 EE-process

On the whole, the process of empowerment evaluation is relatively simple and has a strong universality. It is mainly divided into 4 steps (Fig. 2).

1) Form an evaluation team: the team is formed according to the assessment object;

2) Develop an evaluation scheme: the evaluation task is clearly defined to develop an evaluation scheme;

3) Assess the changes in capabilities brought about by evaluated information;

4) Plan for future: explore future strategic planning.

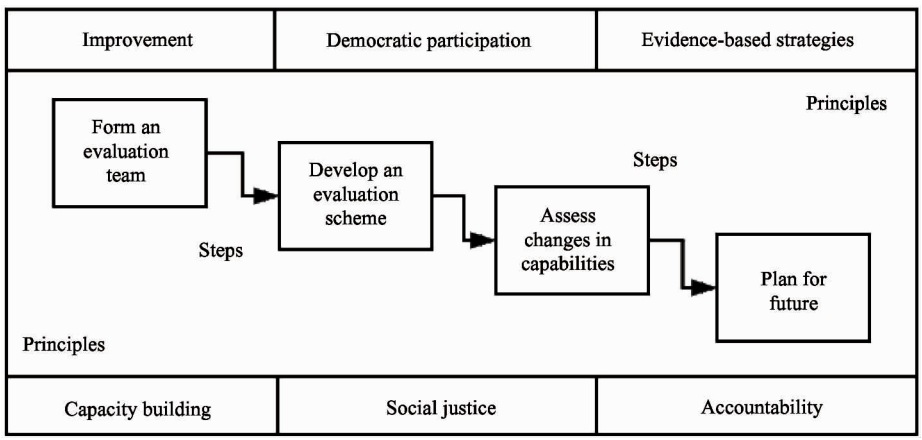

Fig. 2 Empowerment evaluation process

There are some principles which suggest to be associated with the process of an empowerment evaluation. These principles of empowerment evaluation mainly include the following:

1) Improvement;
2) Capacity building;
3) Democratic participation;
4) Social justice;

5) Evidence-based strategies;

6) Accountability.

Research and management personnel should profoundly recognize that the empowerment evaluation process in national S&T information governance is based on the understanding of the relationship between knowledge and action[22]. In actual information governance work, EE-process can be combined with information awareness and full specture analysis methods. The perception, characterization and response of S&T information are the core links of the national S&T information work, and constitute the major concern for the empowerment evaluation of the national S&T information governance.

2.3 The characteristics of empowerment evaluation

Compared with the traditional evaluation methods, the empowerment evaluation is different in its specific operation, which is mainly reflected in 2 aspects.

1) Firstly, in the evaluation team formation, the empowerment evaluation emphasizes multi-faced collaborative participation. The evaluators can be representatives of information activities, partners, stakeholders, and other representatives from different levels, bringing people together to work for a common mission, making full use of human ability to pursue progress, enabling evaluators to learn and improve their ability during evaluation activities.

2) Secondly, capacity building is emphasized on the program and content of empowerment evaluation.

This evaluation activity not only needs to pay attention to the significant progress related to the technology itself, but also pays attention to the strategic vision and security of science and technology. Social problems surrounding the development of science and technology should not be ignored. The empowerment evaluation is not only a quantitative assessment of existing or possible S&T achievements, but also the ability to promote the sustainable development of S&T and encourage innovation and development. This framework attempts to overcome shortcomings of traditional review, such as over-quantification and administrative-led, and emphasizing on empowerment and innovation to create a healthy ecology.

3 Experiment and analysis

3.1 EE-tools improvements

The empowerment evaluation should use appropriate methods based on its tasks. The choice of evaluation tools depends on the setting of the evaluation objectives. As the complexity of technology increases, while considering the technical issues, social and human influences around it cannot be ignored. A single quantitative or qualitative approach cannot meet the needs of national S&T development and security concerns. Under the influence of big data environment and new evaluation concept, the EE-tools should form a diverse combination of inclusive technology and humanities. The improvements have been mainly reflected in 2 aspects: 1) It has introduced new concepts and proposed collaborative participation in the evaluation; 2) It has made evaluators rethink the traditional concept of quantitative evaluation and leverage the power of big data technology tools to present diverse social and academic exchanges in a structured form.

3.2 Example A: participatory technology assessment

In addition to focusing on technology development itself, the impact of the human environment and regard ability as one of standards for evaluation should be also considered. One of the representatives of the practice is the participatory assessment. Broadly speaking, participatory technology assessment (TA) is a general term for assessment methods and procedures for certain types of social and technical problems. It emphasizes that various social roles can actively participate in assessment and discussion. These participants can be different types of civil society organizations, representatives at the national level, or individual stakeholders, especially scientists and technical experts. Participatory TA is believed to[23]:

1) Enhance the knowledge and values base of policy-making;

2) Open up opportunities for conflict resolution and achieves the public good;

3) Foster the motivation of those involved and initiate a process of social learning;

4) Provide economic actors with a better understanding of consumer and stakeholder concerns;

5) Improve the accountability and legitimacy of socio-technological decisions.

Different combinations of participants constitute different types of assessments[24] (Table 1). Participatory assessment not only examines and evaluates science and technology at a purely scientific level, but takes into account broader social, ethical, and political aspects. Moreover, participatory assessments facilitate open public domain assessments, help to make the assessment process more transparent, and encourage broad public discussion and social learning.

Table 1 Number and heterogeneity of participants

Number and heterogeneity of participants							
Participants	Type 1 Dialogue proeedure	Type 2 pTA in a narrow sense	Type 3 legal public hearing	Type 4 Consensus conference	Type 5 Extended consensus conference	Type 6 Voting conference	Type 7 Scenario workshop
Lay people			✓	✓	✓	✓	✓
Sci. experts		✓	✓	✓	✓	✓	✓
Interest groups	✓	✓			✓	(✓)	✓
Policy-maker						✓	✓
Key feature	Interest group procedure	Expert-stakeholder procedure	Decision oriented procedure involving those concerned	Lay people-expert procedure	Lay people, interest groups and experts	Voting-oriented procedure	Procedure involving those affected, experts and policy-makers
Criteria for selecting participants	Representative; partly affected groups	Representative	Everybody; those who feel affected	A-citizens; representative & 'lottery'; B-experts: deliberate selection by lay people	Same as A; Same as B; C-interest groups: co-optation	Same as A; experts & policy-makers: representatives	Representative

3.3 Example B: Altmetrics

Empowerment evaluation concept can be reflected in the development of measurement-based scientific evaluation tools. The traditional scientific measurement evaluation is mainly based on the measurement of the information recorded in the literature. It is good at reflecting the influence of the literature, but its analysis dimension is relatively single and the time lag is long. Bibliometrics is difficult to estimate the motivation of researchers, and the neglect of the Matthew effect and the Gudha's specific law of citation evaluation has brought negative impacts on evaluation work and technology management. In this case, Altmetrics, a complementary metrology, was developed to reflect all of the researcher's scientific research trajectories and the use of information resources through social networks, academic exchange platforms, and open access platforms[25] (Fig. 3).

Altmetrics uses the data of recommendations, sharing, and discussion to assess the impact of research, and sometimes even add the function of sentiment analysis to the measurement tools. Then it can analyze and evaluate the humanities communication and the inheritance of scientific ideas behind big data[26]. Altermetric. com is an Altmetrics research tool developed by Euan Adie in 2011 that evaluates the impact of academic papers by combining their data on different social networks and online media. The altmetric score is a measure of the amount of social media impact that Altmetric. com calculates based on data sources and score weights[27] (Table 2).

Table 2 The Altmetric attention score

Data source	Score	Data sources	Score
News	8	Q&A	0.25
Blogs	5	F1000/Publons/ Pubpeer	1
Twitter	1	YouTube	0.25
Facebook	0.25	Reddit/Pinterest	0.25
Sina Weibo	1	LinkedIn	0.5
Wikipedia	3	Open Syllabus	1
Policy Documents (persource)	3	Google	1
Q&A	0.25	Patents	3

In 2017, Altmetric has tracked over 18.5 million mentions of 2.2 million different research outputs and selected the top 100 most-discussed jounal articles of 2017, ranked in the order of the Altmetric Attention Score[28] (Table 3).

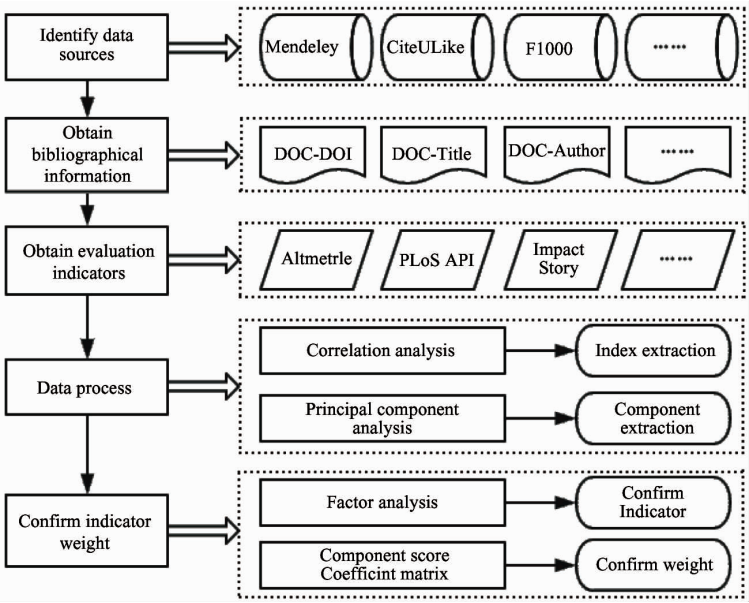

Fig. 3 Altmetrics evaluation model

Table 3 Altmetric-top 10 articles

Rank	score	Title	Journal	OA	News stories	Blog posts	Tweets	Facebook posts	Wiklpedia pages	Google + posts	Mendeley readers
1	5 876	Associations of fats and carbohydrate intake with cardiovascular disease and mortality in 18 countries from five continents (PURE): a prospective cohort study	The Lancet	Paywalled	168	21	8 313	441	0	2	501
2	5 060	Work organization and mental health problems in PhD students	Research Policy	Paywalled	21	9	7 368	117	0	4	878
3	4 715	Comparison of hospital mortality and readmission rates for medicare patients treated by male vs female physicians	JAMA Internal Medicine	Paywalled	345	43	4 098	74	5	10	194
4	4 510	Correction of a pathogenic gene mutation in human embryos	Nature	Free to view	370	87	4 413	108	0	32	751
5	4 410	Gender stereotypes about intellectual ability emerge early and influence children's interests	Science	Paywalled	440	29	1 950	98	1	9	294
6	4 281	More than 75 percent decline over 27 years in total flying insect biomass in protected areas	PLoS ONE	Open Access	206	34	3 917	123	3	22	311
7	4 016	Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2 416 population-based measurement studies in 1 289 million children, adolescents, and adults	The Lancet	Open Access	367	8	2 956	60	0	0	152
8	3 985	A feathered dinosaur tail with primitive plumage trapped in mid-cretaceous amber	Current Biology	Paywalled	416	39	2 431	68	4	6	165
9	3 920	Efficacy and effectiveness of an rVSV-vectored vaccine in preventing Ebola Virus disease: final results from the Guinea ring vaccination, open-label, cluster-randomised trial	The Lancet	Open Access	438	22	1 976	59	6	2	302
10	3 837	An extra-uterine system to physiologically support the extreme premature lamb	Nature Communi-cations	Open Access	445	31	942	66	0	37	169

At this stage, Altmetrics has not been able to get rid of the embarrassment of traditional measurement indicators in actual operation. It is inevitable that it will fall into defects, and there are shortcomings and controversies. However, the combination of data and humanistic thinking embodied in its development deserves attention. It is foreseeable that technology and humanities, big data and system scanning will continue to be the source of innovation for the combination of empowerment assessments in national science and technology information governance in the coming years.

4 Conclusions

National S&T information governance has certain particularities and complexities. At present, there are still many problems in China's S&T information enterprise. For example, the focus of information work is still at the level of task response, but the research on perception and characterization is not deep enough. S&T information work can participate in providing guarantees for national S&T security governance, but it has not yet formed an ideal strategic support for the national innovation and development. The solution of these problems must rely on the transformation of ideas and concepts, the development of institutional systems and the innovation of tools and means.

'Empowerment' is the result of pursuing special capabilities under a specific value orientation. The changes in related object capabilities triggered by scientific and technical information activities in the new environment are very important. And the multi-person participation and multi-indicator comprehensive evaluation method in the empowerment evaluation framework mentioned above is conducive to the democratic and objective nature of science and technology information governance policy formulation.

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