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Preliminary Research on Visualization of S&T Policy

—A Case Study of China Innovation and Entrepreneurship Graphic Policies

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Abstract

Based on the current status and trends of S&T (science and technology) policy communication, this paper establishes the concept of policy visualization and describes the main applicability of visual policy. Next, we study the procedural requirements of S&T policy visualization on four aspects: subject selection, content analysis and information processing, policy graphic designation, media promotion. By this study, we recognize that the visualization of China's S&T policy has some problems, such as, the difficulty in the definition of the authority of policy graphics, in homogeneity and the lack of dynamics in the effect of graphic policy and so on. Furthermore, the paper puts forward some suggestions to improve the development of S&T policy visualization according to the existing problems.

Keywords

1. Introduction

China's scientific and technological innovation has entered the new era of mass innovation. In order to boost mass entrepreneurship and innovation the Chinese government has issued and implemented a series of effective S&T policies. Under this background, the scope of China's S&T policy audiences has been greatly enlarged. However, traditional policy communication channels often cause information distortion and the feedback channels are always blocked due to the limited radius and closed system, easily leading to the ignoring of the public interest demands and policy failure. Therefore, we are required to re-examine the mechanism and propagation paths of policy communication so as to seek a more effective way. S&T policy visualization is an application of

visualization technology in the field of S&T policy, which is of great significance for policy communication. Firstly, it can motivate the enthusiasm of the audience's awareness of the policy by transforming the policy content into visual information. Secondarily, it is a powerful tool to improve the efficiency of policy communication with the use of computer technology and visualization tools which can greatly reduce the policy dissemination costs. Last but not least, it is an effective way of fostering democratic participation, since it provides a more convenient channel for citizens to express their demands and lowers the threshold of civil participation. Based on the case study of China's innovation and entrepreneurship graphic policies, this paper is intended to provide an overview of S&T policy visualization in China. In Section 1 we start with the concept of policy visualization and traced the status and trends of S&T policy visualization communication. Not all science and technology policies are suitable for visualization, so this paper analyzes the main applicability of visual policy on four aspects in Section 2. Then we proposed the communication mechanism of S&T policy visualization in Section 3 and further discussed its detail procedures. In Section 4 some problems of S&T policy visualization are listed, and several corresponding suggestions for the improvement of S&T policy visualization are put forward finally.

2. Status and Trends of S&T Policy Visualization Communication

2.1. From the Visualization to the S&T Policy Visualization

The famous experimental psychologist Fischer has confirmed that 83% of human information obtained from the vision through a large number of experiments. In comparison to text, visual images need less energy to be consumed. In brief, visualization is the full use of the fastest and most wide-band capabilities of the human eye-brain system to deliver, process, and interpret information [1]. Visualization originated in the late 1980s, with the emergence of Visualization in Scientific Computing as a symbol. The development of visualization roughly follows the trajectory of Visualization in Scientific Computing, Data Visualization, Information Visualization, and Knowledge Visualization. With the emergence of graphic policy in the last two years, the visualization technology has been widely applied to the field of S&T policy communication. The use of visual metaphors is effective for the transfer of knowledge [2]. Knowledge visualization aims to improve the transfer of knowledge among at least two persons or in groups by using visual representations. The information transmitted by the communicators actually is processed and ordered information, which belongs to the category of knowledge [3]. According to the definition of Knowledge Visualization and its main features, the S&T policy visualization can be defined as a part of knowledge visualization to a certain extent. It is a transformation of policy information manifestations in order to promote the transmission of a policy and make the core content and spirit of S&T policy comprehensible to recipients. It can increase recipient's remembrance of the policy and influence their behaviors in daily life. As a consequence, the development of S&T innovation can be promoted.

2.2. Rise and Development of Graphic Policy

Today, China's S&T policy visualization is still in its infancy, we clarify the form of S&T policy visualization into three categories, **Table 1** shows the main forms of S&T policy visualization. Graphic policy is the primary form of S&T policy visualization whose rise is closely associated with the coming of "the era of reading images". With the coming of "the era of reading images", reading images has become the main way of people perceiving and understanding the world, audiences begin to get information on the basis of personalized choice. In response to this trend, communication subject began to interpret the public policy in the form of diagrams. It is

Table 1. The main forms of S&T visualization.

	Forms		
	Static graphic policy	Dynamic interaction diagrams	policy animation
Illustration	The simplest form:using pictures or information figures to present the framework and main points of the policy with concise and comprehensive text.	The dynamic form: the dynamic interaction diagrams which integrating big data can achieve human-computer interaction through hot links and flash animation. Audience can query the details by clicking the mouse.	Most vivid form: take the video or slide as the carrier to demonstrate the main content of S&T policy. Through the combination of voice, music and animation it can show more rich content in a vividly way.

in the print media that graphic policy first appeared. With the further development of e-government and the disclosure of government information, more and more government websites have frequently taken the form of graphic interpretation to interpret S&T policy since 2014. The website of the Central People's Government of the People's Republic of China has opened up a special graphic section, the policy interpretation section of the Ministry of Science and Technology, the Graphic news column of People's daily online and the website of Net Ease news all launched a series of graphic policies. Dynamic interaction diagrams and policy animation are more flexible and dynamic. However, due to the high production costs and the complexity of high-tech, these two forms are not widely used.

2.3. The Status of Innovation and Entrepreneurship Policy

Mass entrepreneurship and innovation are the hottest issue in china today which attracts the whole society's attention. Premier Li Keqiang has held hundreds of Executive Meetings of the State Council, "Mass entrepreneurial and innovation" and "Entrepreneurial and Innovation" has become the high-frequency words mentioned in the meeting. In the first half of 2015 alone, the Executive Meetings of the State Council has made arrangements for the promotion of "Mass entrepreneurial and innovation" at least eight times. There have been 13 policies related to innovation and entrepreneurial among the 25 S&T policies released in the website of the Central People's Government of the People's Republic of China since the 18th National Congress of the Communist Party of China. The scope of innovation and entrepreneurship policy recipients has been greatly enlarged and presented a tendency of popularization. Innovation and entrepreneurship are quite energetic and dynamic in nature, which also determines the urgency of innovation and entrepreneurship policy dissemination. Therefore, innovation and entrepreneurship policies need to be propagated in a more effective way. There are 28 graphs related to innovation and entrepreneurship in the 84 graphs released in the section of the Executive Meetings of the State Council Graphon the website of The Central People's Government of the People's Republic of China and almost all the policies directly related to innovation and entrepreneurship are widely spread through visualization technology. The website of The Central People's Government of the People's Republic of China and the multi-media production center of Xinhua Net designed a series of graphic policies together, which have been forwarded lots of times by many local government official websites and multimedia platform in a short time with a viral spreading.

3. The Applicability of S&T Policy Visualization

3.1. Policy Content & Visualization

The primary goal of policy communication is to arouse audience's awareness of a policy, to convey policy content to the audiences, and prompt the audiences to implement the policy [4]. Whether the content of communication can be understood and accepted by recipients mainly depends on two aspects: one is the reduction of language difficulty, and the other is the improvement of content humanity. It involves with the legibility and depth of the policy content. Legibility is mainly reflected in the framework, content length and language features of a policy. Take the "Guideline on Measures to Boost Mass Entrepreneurship and Innovation" as an example, nine specific measures to support mass entrepreneurship and innovation are laid out. The "Guideline" is divided into 11 parts and have more than 7000 words in total which can be a large reading quantity for the audiences. With the plain and serious language audience may prone to fatigue in reading. As a result, audiences get a poor effect in remembering the policy. But when getting a quick view of the "Guideline" in a visual figure, like **Figure 1**, the audience's reading speed can be accelerated. Moreover, the depth of a policy is primarily reflected in professional content. Another simple example is the "Guiding Opinions on Accelerating the Construction of the Mass Entrepreneurship and Innovative Public Support Platform". This "Guiding Opinions" contains many specialized vocabularies such as "crowd-founding", "crowd-sourcing", "collective support" and "the same address with multiple business licenses" which will increase the difficulty of the audiences who has never heard those words before to understand the policy. Therefore, visualization is necessary for professional S&T policy of rich content, meticulously framework and rigorous language.

3.2. Policy Forms & Visualization

The S&T policy can be divided into three categories from the form of manifestation, namely, the legislation of

Figure 1. A quick view of "Guideline on Measures to Boost Mass Entrepreneurship and Innovation".

S&T policy, the S&T policy based on department regulations and local legislation, the S&T policy based on the regulatory documents. Standardized legal language is used in the first category, such as "Law of the People's Republic of Science and Technological Achievements Reforming Process". There is a contradiction between the logic of legal language and the audience's demand for understandability. Although legalization has been closely interconnected with social life, more and more people are being faced with the difficulties in reading laws. As for such kind of policy, it is necessary to accomplish the language translation and professional docking between communicator and recipients in the premise of guaranteeing the credibility and authority of a policy. The second kind of S&T policy generally refers to "Detailed rules for the implementation", "Regulations" and "Measures". Which is the guidance or regulation of the concrete implementation of the general policy, so visualization can be used to improve policy publicity and implementation as well as the audience's interest in reading. S&T policy based on the regulatory documents, such as "Circular", "Opinions", "Code", "Decisions" and "Plans" is related to specific science and technology program management or affairs. A simple sketch map combined with necessary text can help audiences grasp the core points of the policy. This paper has counted the number of S&T policy released in the website of the Central People's Government of the People's Republic of China since the 18th National Congress of the Communist Party of China. The percentage can be seen in **Figure 2**. According to the results, the "Circular", "Opinions" and "Decisions" accounted 90% among the total 25 S&T policies. More than half of the policies have been made into graphics, and those graphic policies are consisted of "Circular" and "Opinions". Policy like "Reply", "Request instructions" are refining and highly targeted, they just spread within the departments without visualization.

3.3. Policy Timeliness & Visualization

Time is just one of the most important factors that influence policy communication. Any policy has its timeliness and longer propagation process is more likely to cause transmission delay as well as information distortion. It is easy to cause policy failure if the policy cannot be delivered to the target recipients in time. First of all, the timeliness of a policy refers to its life span. Furthermore, there exist time lags in the process of policy communication. Because we take time to convey the policy from the communicator to the recipients and recipients also need time to understand the content. The existence of time lags increases the risk of policy timeliness. The innovation timeliness is particularly urgent in the field of science and technology innovation. The more forward-looking and innovative the policy is, the more efficiency is needed to convey the policy information to the recipients. S&T visualization enables audiences to grasp the core content of the policy and deepen their memory of a policy in the shortest time by compressing and repacking the policy information in the forms of graphics. Moreover, S&T policy visualization can minimize the time lags of policy communication with the help of new
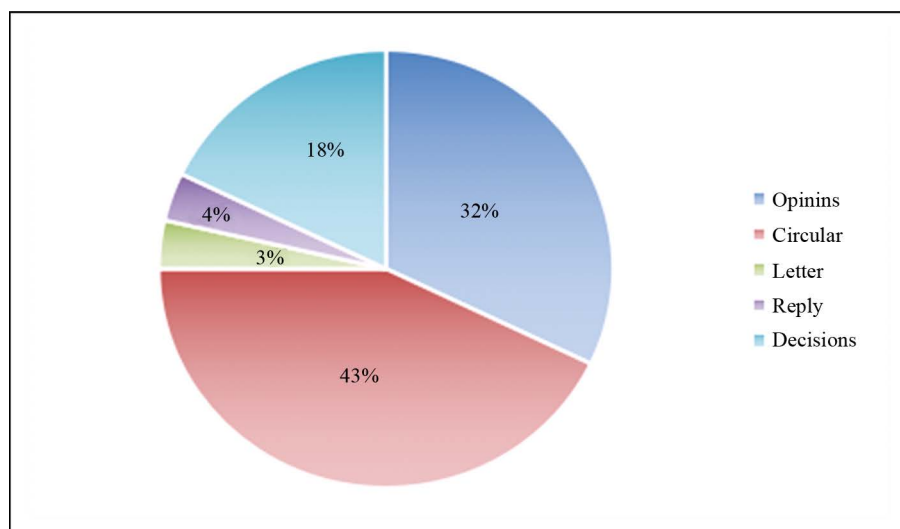
Figure 2. The pie chart of S&T policy graphics released in the website of The Central People's Government of the People's Republic of China since the Eighteenth National Congress of the Communist Party of China.

media and modern network technologies.

3.4. Policy Hierarchy & Visualization

Hierarchy is the basic attributes of public policy. There may exist several hierarchies from policy-making to its final implementation which may cause information distortion or misinterpretation during the policy process [5]. Thus, the higher the hierarchy of a policy is, the more the links and procedures are during the policy communication. And the slower speed of policy communication the more serious of the information distortion. It is quite necessary to adopt visualization technology to promote policy propagation. Take the "'1 + 6 + 2' policy supporting the construction of innovative province in Anhui Province" as an example，in order to improve the pertinence and operability of the supporting policies the government of Anhui Province has revised the supporting policies. And according to the supporting policies, the science and technology department of Anhui Province has made a specialized graphic policy, briefly introducing the subsidy object and content of each policy and shows the operating procedures in general. The local governments and the public can find policy information and the most authoritative interpretation immediately online. This policy communication mode has incomparable advantages in communication efficiency with conventional organization communication.

## 4. The Procedural Requirements of S&T Policy Visualization

Not all science and technology policies are suitable for visualization. As an access to the target audiences, S&T policy visualization can greatly improve the effect of policy communication if used appropriately, otherwise it may get half the result with twice the effort. The key point of the visual policy communication mechanism is the visualization of policy information and audience's decoding on policies. This section introduces the framework and detail procedures of S&T policy visualization communication mechanism in **Figure 3**.

4.1. Subject Selection and Audiences Definition

The foremost problem of policy visualization is the selection of visualization subject. Visualization subject is the gatekeeper of policy information who needs to consider the problems in all aspects and ensure the authority of graphic policies. We have calculated the graphic policy posted in the central and local government websites. Depending on the statistics, we found that the government agency who issued the policy is also the subject of policy visualization in generally. The higher hierarchy of the subject is, the greater the possibility of adopting visualization technology is. The subject should define audiences scientifically. On one hand they have to define the scope of audiences, on the other hand they have to know the features and demands of the policy audience. It is an indispensable work for the visualization subject to know the habits of policy audiences and their motivation of getting access to different media for the reason that the behavior of the audiences are influenced by their interests or demands to a great extent.

4.2. Content Analysis and Information Processing

Visualization technology overcomes the limitations that words or data only describe things in a linear way and
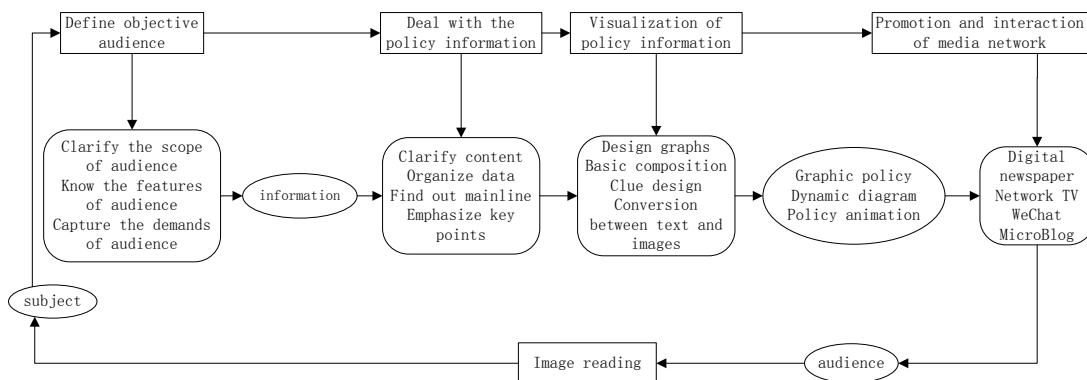
Figure 3. The framework and procedures of S&T policy visualization communication mechanism.

can further demonstrate the principles and structure of things. Visualization is not a unconstrained creation deviated from the policy content but a transformation of forms loyal to the content. Therefore, the visualization subject needs to analyze the policy information scientifically. The key point of the policy information analysis lies in the reasonable selection and classification of the content. We are required to sort out the related data accurately and find out the main line of the content, irrelevant content must be abandoned and key points should be highlighted. In addition, audiences' memory is selective. If the existing cognitive background of audiences is more relevant to the information demonstrated on the visualization interface, the audience's memory about the visual policy will be more profound. Therefore, an efficient S&T policy visualization should be customized to the recipients' cognitive background and demand. In addition, arrangements need to be carefully made on the policy formation and policy content, reasonable collocation of visual elements and characters is essential to enhance the audience's awareness of the policy. Moreover, we can guide the changing of audience's behavior by expected designation.

4.3. Visualization Graphs Designation and Co-Ordination

The key step of S&T policy visualization consists of maximize the integration of visual language into information and to convey the abstract information in a vivid way by using list, chart, graph, diagram, links and other means of expressions. For example, illustrated charts can attract audience's attention with humorous expressions, the dendrogram can clearly sort out complex data and illustrate relations through its systematic and orderly structure. Many knowledge visualization methods can be applied to the designation of visualization graph. Such as Mind Map, Cognitive Maps, Semantic Networks, Concept Map, Thinking Map and representation of Geometric line, color representation, Multimedia representation in engineering science [6]. Visualization subject should take people's reading habits into consideration and follow the principle of visual orientation in the process of the visual graphs designation. Utilizing basic composition and clue designation to guide the audience's thinking process is also important. Take full advantage of lines, colors and other factors for modification in the graphics. To further enhance the audience's understanding of the policy the subject should innovate basic figures and combine literal symbol with visual representation effectively. Besides, in terms of information communication, visualization subject should follow the designation principles to emphasize the logical relationship and physical architecture of the policy. And always adhere to the principle of the coexistence of readability and logicality so as to ensure the unity of the overall design style of the visual graph.

4.4. The Promotion and Interaction of Media Network

Graphic policy is closely connected with the computer technology and the Internet from designation to publication, it needs the support from new media and the Internet to disseminate effectively. The new media that based on digital technology is low in cost and easy in operation, and the Internet accelerates its propagation and information updating. Its open communication structure provides a great way to get feedback from visitors. The rapid development of new media, including the increasing number of people using smart phones and the proliferation of We media has resulted in easier and growing access to a vast reservoir of information. China's WeChat and Micro Blog as the representative of the We media platform is developing rapidly, the number of we media user growth spurt in recent years. At present, the number of monthly WeChat active users is 549 million in China, the WeChat subscriptions has become an important way of getting information and knowledge. Graphic policy can be spread from all persons to all persons through the WeChat subscriptions and MicroBlog subscriptions. Each user can form a new and self-centered information communication network by sharing or forwarding the graphic policy. From the visitors, page hits, comments, forwarding amount and the number of thumbs-up, we can see the specific effect of policy communication visually.

5. Strategies for Improving the Effect of S&T Policy Visualization

With the implementation of S&T policy visualization, audience's desire for policy content has been directly inspired and their demand of getting the core information has been satisfied well, which creates significant effect. However, some disadvantages can't be ignored, such as the difficulty of defining its authority, inhomogeneous in the effect of graphic policy, the lack of dynamics and so on. In this section, we put forward some suggestions to improve the development of S&T policy visualization according to the above disadvantages.

5.1. Strengthen the Supervision of Network Communication and Enhance Audience's Interpretation Accomplishment

Because of the low-threshold, low-cost and low-tech features, the graphic policy has been widely used. In We media era, every member of the society can be free to acquire, create or disseminate information on the Internet. There are heterogeneous graphic policies on various network platforms due to the anonymity and flexibility of the Internet transmission, so the quality of graphic policies varies greatly. As a result, it is very difficult for audiences to effectively identify the credibility and authority of a large number of graphic policies. Thus, multiple measures must be carried out to solve this problem. Firstly the closure of the political system should be eliminated gradually and the transparency of government should be enhanced, so as to improve people's recognition of truthful information. Secondly, the government should strengthen the legislation management of the network transmission and improve the legislation in the field of network transmission. Meanwhile, efforts should also be made to strengthen the regulation of media and the refuting of rumors. Accelerating the construction of the examining and licensing system as well as the content inspection system and formulating industry standards for the Internet transmission are also important. Thirdly, it is essential to create a free, equal and healthy media ecology and establish a value benchmark system of the Internet communication, it is meaningful to give full play to the role of moral opinion and social supervision and resolutely resist the spread of crude content. Finally, more attention should be paid to the cultivation of the audience's interpretation accomplishment. The visualization subject should not only promote the mainstream values vigorously and guide the correct public opinion, but also strengthen the supervision and guidance of the policy concepts and to improve audience's decoding ability and the ability of distinguishing true information from fake.

5.2. Accelerate the Construction of Interpretation Network and Enlarge the Talent Team

Under the current policy interpretation network, once a policy is issued, the local media lacking of originality often copy the interpretation of the central media, while social media tends to interpret it in a personalized way. On this foundation, together with the immature visualization mode and developing talented team, the effect of China's graphic policy is inhomogeneous. For this reason, it is necessary to build up multi-layer radiative interpretation network and accelerate the construction of talented team. First of all, central media as the authority subject should focus on the comprehensive interpretation combine with profound analysis and guarantee the authority of the interpretation direction. After that, the websites of local government should strengthen the subjective initiative and interpret the policy according to the local situation under the premise of adhering to the policy guideline. Meanwhile, the visualization subject should submit the audience's opinion to the relative government departments during the communication process and improve civil participation through interaction so as to promote the implementation of policies. Then, other social media should abide by professional ethics and explore more visualization forms to keep close to the public. Continuously improve the quality and level of visual policy and enhance the credibility of interpretation content [7]. In addition, visualization subject should also promote the development and expansion of professional talented team, pay more attention to foster staff's information processing skills and improve their ability of text editing and computer operating.

5.3. Enhance the Designation of Dynamic Interaction Diagrams and Improve Static Graphics

The designation and selection of graphic policy is mostly based on the static graphics, so the content finitely demonstrated in the form of the combination of text and data tables. It would be unconventional for the audiences to query the details of the policy because the graphics only extract key points of the policy. In the development of policy visualization, the interaction of dynamic graph is not enough which greatly restricted the participation of the communication. Interactive visualizations are computer-based electronic visualizations that enable the users to control, combine, and manipulate different types of information or media. Interactive visualizations enable new methods to design, to explore and to communicate [8]. Interactive visualization helps audiences to gain more detailed information about the topics they are interested in by a simple operation. So the S&T policy visualization needs to take full advantages of the support from artificial intelligence, knowledge science and computational linguistics to change from static designation to dynamic designation and to enhance the intertextuality and participation of visual policy. At the same time, the visualization subject should pay attention to the use of dynamic graph technology, interactive technology and media integration technology to further

develop the S&T policy visualization combined with the policy animation and interactive skills. Visualization has great advantages in the presentation of logicality and relevancy. So it is of great significance to make full use of these advantages to help the audiences to organize thought and change their behaviors.

5.4. Strengthen the Integration of Three-Dimensional Interpretation and Improve Depth Analysis from Professional Perspective

Graphic policy only focuses on the descriptive and introductory interpretation of the policy, it is just a display of facts lacking of authoritative comments and three-dimensional interpretation. Owing to the deficiency of data support, a simple graphic policy cannot surpass the policy text. Although the descriptive interpretation of the graphic policy can improve audience's awareness of the policy content to some extent, but it did not significantly enhance the public's understanding of the policy, audience's recognition and attitudes towards the policy content cannot be improved through descriptive language. So, graphic policy should strengthen its integration of three-dimensional interpretation and improve profound analysis from professional perspective. During the process of editing, the interpretation should be combined with every step of the policy promulgating background and help audiences to know the reason of the policy from the beginning to the end. Next, the subject can also invite experts, policy researchers or scholars comments on or analyzes the relevant issues of the policy to enhance the level and depth of interpretation. In addition, expanding the information sources is also essential, we can convey the spirit of the policy by internalizing the logical relationship of data in visual images and improve the credibility of graphic policy by strengthening the use and analysis of the data.

6. Conclusion

S&T policy visualization is a new way of policy communication in the information age. This is an inevitable trend under the background of government flattening and picture-reading time and can solve the problem of information overloading effectively. We found that there have some requirements in the content, form, timeliness, hierarchy of the S&T policy visualization through the analysis of China's innovation and entrepreneurship policy graphics. And the visualization of S&T policy needs four steps, that is subject selection and audiences definition, content analysis and information processing, visualization graphs designation, promotion and interactions of media network. Currently, China's S&T policy visualization is still in its initial stage and still has some problems. Because of its low-threshold features, it is difficult for audiences to identify the authority of the graphic policy. Together with the immature visualization mode and developing talented team, the effect of China's graphic policy is inhomogeneous. And, static chart as the main form of graphic policy lacks interactivity and participatory as well as deep analysis. Above all, there still has some improved space. In the development of S&T policy visualization we should improve the construction of system and talented team, and pay more attention to the cultivation of audience's interpretation accomplishment as well as the application of interactive visualization method. Finally, strengthening three-dimensional interpretation and deep analysis is also very important.

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