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Abstract

In the process of advancing the modernization of the national governance system and governance capacity, the important role of think tanks becomes increasingly prominent. Because of the comprehensive crossover characteristics of think tank research problem, it manifested as different scale research problems. The research process follows the general and common methods of the think-tank DataInformation-Intelligence-Solution (DIIS) theory, and has different key elements and steps. Grasping these key elements and steps and forming different scale DIIS methods can provide effective tools and methods for individuals, research groups and research teams to investigate the think tank research problems. From the perspective of crossing, relevance, and complexity, this study analyzes the characteristics of largescale, medium-scale, and small-scale think tank problems, and develops the process of dividing the scale of think tank problems. Secondly, large-scale, medium-scale, and small-scale think tank DIIS methods are proposed based on the DIIS theory, and the relationships of them are investigated. Finally, the DIIS writing specifications of think tanks of different scales are developed in order to ensure the normative and high quality of think tank research and to better play the role of think tank.

Keywords

think tank; DIIS; multi-scale; think tank research method

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DIIS Theory and Methodology for Multi-scale Think Tank Issues

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Abstract: In the process of advancing the modernization of the national governance system and governance capacity, the important role of think tanks becomes increasingly prominent. Because of the comprehensive crossover characteristics, the think tank research problem is manifested as different-scale research problems. The research process follows the general and common methods of the think-tank Data–Information–Intelligence– Solution (DIIS) theory and has different key elements and steps. Grasping these key elements and steps and forming different-scale DIIS methods can provide effective tools and methods for individuals, research groups, and research teams to investigate the think-tank research problems. From the perspective of crossover, relevance, and complexity, this study analyzes the characteristics of large-scale, medium-scale, and small-scale think tank problems, and develops the process of dividing the scale of think tank problems. Secondly, large-scale, medium-scale, and small-scale think tank DIIS methods are proposed based on the DIIS theory, and the relationships of them are investigated. Finally, the DIIS writing specifications of think tanks of different scales are developed in order to ensure normative and high-quality think tank research and to better play the role of the think tanks. **DOI:** 10.16418/j.issn.1000-3045.2019.07.008-en

Keywords: think tank; DIIS; multi-scale; think tank research method

In recent years, China has paid more attention to the construction of top think tanks and issued a series of policy documents. For example, in January 2015, the General Office of the CPC Central Committee and the General Office of the State Council issued the "Opinions on Strengthening the Construction of New Types of Think Tanks with Chinese Characteristics," pointing out that the construction of new types of think tanks with Chinese characteristics should be effectively strengthened and the important role of think tanks in the governance of the country should be given full play to. In February 2017, the thirty-second session of the Central Leading Group for Comprehensively Deepening Reform approved the "Construction Plan of National S&T Decision-making Consultation System," making it clear that China would build the top think tanks for science and technology decision-making. In October 2017, General Secretary Xi clearly stated in his report to the 19th CPC National Congress that the construction of new types of think tanks with Chinese characteristics should be strengthened.

With the increasing importance of think tank construction, it is urgent for think tanks to grasp the rules and characteristics of global and national conditions and have an insight into the future development trend through scientific theory and methodology, so as to provide forward-looking advice and systematic solutions for decision-making. However, the lack of systematic methodology is a common problem in China's research on think tank consulting [1]. To solve this problem, Pan [1] summarized the general process of think tank research and thought deeply about the methodology of think tank research from the perspective of Data–Information–Intelligence–Solution (DIIS) for the first time. Then, he proposed the DIIS theory and methodology of think tanks under the Problem orientation, Evidence orientation, and Science orientation. Subsequently, Pan et al. [2] considered the methodology of the whole process of think tank research from the perspective of dialectics, systems theory, and convergence view summarized the general rules followed by think tank research and expatiated the DIIS theory and methodology of think tanks and the DIIS quality standards of think tank reports. Furthermore, Pan et al. proposed a three-dimensional theoretical model of think tank DIIS from the three dimensions of the research process, think tank ori-

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entation, and methods & tools, and made an in-depth analysis of the model from different views. The views include the front view based on the research process and think tank orientation, the top view based on the research process and methods & tools, and the left view based on methods & tools and think tank orientation, to further explore the systematic methodology of think tank research. Pan et al. [3] applied the DIIS theory and methodology to science and technology evaluation and further proposed DIIS methods for science and technology evaluation. The DIIS theory and methodology systematically analyze the process of think tank research, which provides an important guarantee for the scientific and high-quality think tank research and offers path guidance for the formation of think tank "digital laboratory" with strategic consulting function.

However, in the think tank research and practice, we usually encounter think tank issues of different scales. For example, small-scale think tank issues usually focus on a single discipline or field, with little correlation, and independent researchers can carry out the problem research. The medium-scale think tank issues often involve limited disciplines or fields, which are interrelated to a certain extent and require a research group composed of several researchers to complete the research. The large-scale think tank issues, often macroscopic strategic and policy problems, have the characteristics of multi-disciplinary and multi-field crossover and are highly interrelated, and their research needs to be completed by multiple research groups. The research on think tank issues of different scales, while following the general and common methods of think tank DIIS theory, has their own key elements and steps, thus forming DIIS methods of different scales, providing methods for individuals and teams to conduct research on think tank issues more scientifically and efficiently. How to scientifically understand the above has become an important issue worthy of an in-depth discussion in the process of Chinese think tank construction.

This paper first analyzes the main characteristics of think tank issues of different scales and proposes the process of dividing the scale of think tank issues. Secondly, based on the think tank DIIS theory, the think tank issues of different scales are reconsidered, and the large-scale, medium-scale, and small-scale think tank DIIS methods are proposed. Finally, the DIIS writing specifications of multi-scale think tank reports are given to promote the normalization, standardization, and scientificity of think tank research and enrich the methods & tools of think tank research in China.

1 Scale division of think tank issues

During the research on think tank issues, it is necessary to divide the scale of think tank issues with professional knowledge first, thus clarifying and simplifying the problems. Therefore, in this section, we analyze the main characteristics of large-, medium-, and small-scale think tank issues and give the process of dividing the scale of think tank issues.

1.1 Characteristics of think tank issues of different scales

The research scale of think tank issues can be judged by the degree of crossover of disciplines or fields (crossover), the degree of interrelationship (relevance), and the composition of researchers (complexity) (Table 1). Based on the crossover, relevance, and complexity, this paper divides the think tank issues into large, medium, and small scales. The main characteristics of think tank issues of each scale are detailed as follows.

1.1.1 Characteristics of large-scale think tank issues

① Strong crossover: Large-scale think tank research often provides consulting services for development planning and strategic decision-making, and is usually a global and strategic think tank issue. Therefore, the amount of information and knowledge required to study large-scale think tank issues is very extensive, and it is comprehensive research involving multi-disciplinary and multi-field crossover. ② Strong relevance: The large-scale think tank issues are usually not generated independently, but accompanied by a series of problems that are interrelated and mutually influenced, and they often derive and cause many interrelated new problems. ③ Strong complexity: The large-scale think tank issues are complex problems with a high degree of crossover of multiple disciplines and fields, which require an overall and systematic analysis from a global perspective. Therefore, the research is usually completed jointly by researchers with different professional backgrounds and a research team composed of multiple research groups.

For example, in 2007, the Chinese Academy of Sciences (CAS) organized and carried out strategic research on the development of science and technology in important fields such as energy, ocean, water resources, mineral resources, advanced materials, nanotechnology, large-scale scientific facilities, and major interdisciplinary frontiers. A number of core scientific issues and key technical issues have been proposed, and the roadmap for Chinese scientific and technological development in 18 important fields by 2050 has been formed [4]. In the research process, corresponding research groups are set up in each field, and the research is carried out in a combination of horizontal and vertical ways. In the horizontal aspect, the research groups in various fields coordinate or organize cross-field and cross-research-group discussion to ensure the organic integration of related fields. In the vertical aspect, the research groups in various fields are divided into several research groups according to the specific content of the field. Through concentrated discussion,

sub-group research, and comprehensive integration, the experts in this group are organized to conduct in-depth research, and at the same time, the opinions of experts in related fields are absorbed. The research covers the main disciplines of natural science, technology, and engineering, and spans many fields such as technological innovation, industrial economy, ecological environment, social development, and national security. It gathers hundreds of high-level technology, management, and intelligence experts from the CAS, involving more than 80 research institutes, and is a typical study on large-scale think tank issues.

1.1.2 Characteristics of medium-scale think tank issues

① Relatively strong crossover: Compared with large-scale think tank issues, medium-scale think tank issues have a smaller degree of crossover of disciplines or fields, and they are usually studies on the crossover of limited disciplines or limited fields. ② Relatively strong relevance: The medium-scale think tank issues may also derive some issues that are interrelated and mutually influenced, but the degree of relevance is relatively low. ③ Relatively strong complexity: The medium-scale think tank issues involve the crossover of limited disciplines or limited fields and have certain complexity. Therefore, the research needs to be completed by a research group composed of several researchers led by experts in related disciplines or fields.

Table 1 Characteristics of think tank issues of different scales

Type	Crossover	Relevance	Complexity
Large-scale think tank issues	Crossover of multiple disciplines and fields	A series of issues that are interrelated and mutually influenced can be derived	Completed by a research team composed of multiple research groups
Medium-scale think tank issues	Crossover of limited disciplines or fields	Some interrelated issues can be derived	Completed by a single research group
Small-scale think tank issues	Dominated by a single discipline or field	Few interrelationships	Completed by independent research individuals

For example, the National Science Foundation (NSF) in the United States commissioned the National Research Council (NRC) in 2013 to carry out investigations, so as to provide references for its funding strategies and related funding policies for the field of marine science in the next 10 years [5]. Based on a review of the important progress of marine science in the 21st century, NRC has proposed the priority fields of NSF marine science from 2015 to 2025. In the process of selecting priority fields, NRC first determined the set of specific issues to be resolved. Then NRC selected outstanding experts and researchers in related fields to establish a research committee. The experts came from different regions and sectors of the country, including academic circles, industrial circles, government, and non-profit organizations. Furthermore, the research committee carried out high-level and interdisciplinary research on marine science issues around the four subject fields of ocean, climate, ecosystem, and seabed earth. Based on the four selection criteria of potential transformation, social influence, maturity, and potential partners, eight priority fields of marine science were finally selected. For another example, the Institutes of Science and Development, CAS carried out strategic research on the future development of advanced nuclear fission energy in 2016 and conducted in-depth discussions on the industrial application of nuclear energy from 2030 to 2050. During the research process, a project group for the strategic research on future advanced nuclear energy was established, which was led by technical experts and management experts in the field of nuclear energy, and jointly participated by researchers from the Institutes of Science and Development, CAS, the Institute of Modern Physics, CAS, and the Wuhan Library, CAS. Combined with the strategic goals of future development of nuclear fission energy, the project group put forward the solution for nuclear energy system technology that needs to be further developed in the future. In the above two practical studies, a research group conducted crossover research in limited fields, which can be regarded as the research on medium-scale think tank issues.

1.1.3 Characteristics of small-scale think tank issues

① Weak crossover: Small-scale think tank issues usually focus on a single discipline or field, and rarely involve the crossover of disciplines or fields. ② Weak relevance: The research on small-scale think tank issues is very specific, with few other issues involved. ③ Weak complexity: The research on small-scale think tank issues is relatively clear, and the width of the knowledge domain involved is limited. Usually, one researcher can independently carry out the research.

1.2 Process of dividing the scale of think tank issues

Based on the characteristics of think tank issues of different scales, this section gives the process of dividing the scale of think tank issues (Figure 1), so as to facilitate the smooth development of think tank research.

(1) Define the research issues: The professional concepts are used to express think tank issues so that the think tank issues become the issues that researchers can deal with.

(2) Analyze the boundary of issues: The structure of the issues is analyzed. Professional knowledge is used to judge the subject and field of think tank issues, grasp the interrelationship of issues, identify whether the issue derives a series of issues that are interrelated and mutually influenced, and decompose them to form a clear issue set.

(3) Determine the researchers: Combined with the size of the boundary of issues, we can determine the corresponding knowledge structure and number of researchers. If an issue is very complex, a research team composed of multiple research

groups can be selected to work together. Otherwise, a single research group or even an independent research individual can be selected.

(4) Determine the scale of issues: According to the above analysis, the scale of issues is determined. When an issue involves the crossover of multiple disciplines and fields, derives a series of issues that are interrelated and mutually influenced, and needs to be jointly completed by multiple research groups, it can be regarded as a large-scale think tank issue. When the issue involves the crossover of limited disciplines or fields, derives some interrelated issues, and can be completed by a single research group, it can be regarded as a medium-scale think tank issue. When the issue is dominated by a single discipline or field, has few interrelationships, and can be completed by independent research individuals, it can be regarded as a small-scale think tank issue.

(5) Select the research methods: Based on the scale of think tank issues obtained in the previous step, the corresponding method of think tank DIIS research is selected (see the following section).

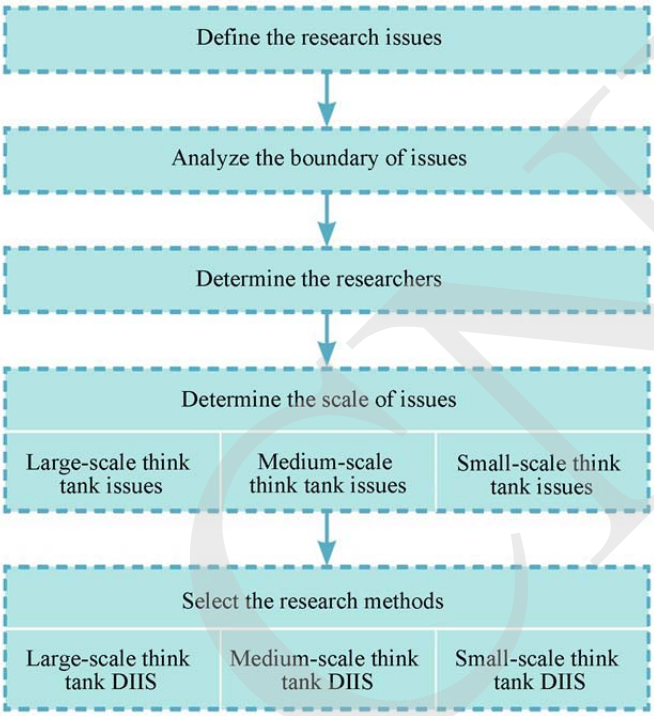

Figure 1 Process of dividing the scale of think tank issues

2 DIIS theory and methodology for multi-scale think tank issues

For think tank issues of different scales, corresponding research methods should be adopted in a targeted manner. Therefore, based on the think tank DIIS theory, this section gives DIIS methods for the large-, medium-, and small-scale think tank issues respectively, so as to provide basic rules, processes, and methods & tools for high-quality, independent, and scientific think tank research.

2.1 DIIS theory and methodology for large-scale think tank issues

The large-scale think tank issues are large-scale strategic consulting issues organized systematically and need to be studied jointly by multiple research groups. Since such issues are relatively macroscopic, the four links of the DIIS chain should be connected under the Problem orientation, Evidence orientation, and Science orientation. The key lies in the systematic integration of the wisdom of experts, iterative deepening, and consensus building to the maximum extent. Therefore, when DIIS is used to carry out research on large-scale think tank issues, it is necessary to focus on the links of Intelligence and Solution. Specifically, for large-scale think tank issues, DIIS research follows the process of four stages of refining issues–analyzing issues–synthesizing issues–solving issues, which correspond to the four links of DIIS on the whole [2]. The specific content of each stage is elaborated below.

(1) Stage of refining issues: In the stage of refining issues, the relevance analysis of issues is carried out by integrating the knowledge of various disciplines; the characteristics of issues are clarified, and the research idea of defining issues–decomposing issues–checking issues–determining issues and the technical route is followed. The stage of refining issues corresponds to the Data of DIIS on the whole, and the four links of DIIS are involved in the research. The specific process is as follows. ① Define issues: Relevant data are collected around the issues. The connections between various disciplines are considered to conduct interdisciplinary and multi-field research on the issues. The research goals, objects, resource constraints, and specific needs are analyzed, and the characteristics of the research issues are defined accordingly. This process involves the Data of DIIS. ② Decompose issues: Discipline re-decomposition is carried out for the issues to be studied and the issues are gradually decomposed into multiple sub-issues to identify the key points of the research on issues. This process involves the Information of DIIS. ③ Check issues: Whether the decomposition of the issues to be studied is comprehensive and scientific is checked. If the issue has been decomposed comprehensively, it can enter the next process. If the issue has not been completely decomposed, it needs to be supplemented with data and re-decomposed. This process involves the Intelligence of DIIS. ④ Determine issues and the technical route: The decomposed sub-issues are analyzed to determine whether they are worthy of study and whether there are relevant studies or

deficiencies in existing studies, and the sub-issues to be further studied are determined. In addition, according to the research goals, objects, resource constraints, and specific needs, the technical route to solve the issues is formed. This process involves the Solution of DIIS.

(2) Stage of analyzing issues: In the stage of analyzing issues, experts in various fields are selected to study the decomposed sub-issues, following the research idea of collecting data-studying sub-issues-judging comprehensively- forming preliminary solutions. The stage of analyzing issues corresponds to the Information of DIIS on the whole, and the four links of DIIS research are involved in the research. The specific process is as follows. ① Collect data: The relevant data of each sub-issue is collected and organized, and experts are selected for the disciplines and fields involved in the research of each sub-issue. This process involves the Data of DIIS. ② Study sub-issues: The relevant data of each sub-issue is organized and analyzed, and an objective cognition is initially formed. This process involves the Information of DIIS. ③ Judge comprehensively: Stakeholder analysis is carried out using methods such as uncertainty analysis and game theory, and each sub-issue is studied and judged comprehensively by integrating the opinions of experts from related disciplines and fields. This process involves the Intelligence of DIIS. ④ Form preliminary solutions: According to the results of comprehensive judgment, the solution of each sub-issue is initially formed. This process involves the Solution of DIIS.

(3) Stage of synthesizing issues: In the stage of synthesizing issues, the preliminary solution of each sub-issue is systematically integrated, and the research idea of integrating research issues-checking research-judging comprehensively is followed. This stage corresponds to the Intelligence of DIIS on the whole, and the specific process is as follows. ① Integrate research issues: The research results of each sub-issue are synthesized to form the integrated research results. ② Check the research: According to the integrated research results, whether the issue is comprehensively studied is checked. If the research is comprehensive, it can enter the next stage. If the issue is not completely solved, new knowledge should be added to carry out research, and the research in the stage of refining issues and the stage of analyzing issues is circulated to deepen the research iteratively. ③ Judge comprehensively: Stakeholder analysis is carried out from a systematic and overall perspective using methods such as uncertainty analysis and game theory, and the opinions of experts in related fields are integrated to conduct the comprehensive judgment on the issues.

(4) Stage of solving issues. In the stage of solving issues, the solution to the issues is formed according to the research of the first three stages, and the research idea of forming multi-scenario solutions-checking reports-generating reports is followed. This stage corresponds to the Solution of DIIS on the whole, and the specific process is as follows. ① Form multi-scenario solutions: Based on the comprehensive judgment results of experts, the solutions to the issues under different scenarios are constructed using scenario assumptions, and the solution sets under different constraints are given to form a preliminary report. ② Check the quality: According to the standard, the quality of the report is reviewed. If the quality standard is met, the report will be generated. If the standard is not met, the above research process will be demonstrated circularly. ③ Generate reports: The solution to the issues is given according to the normalized format, and the final report after the check is generated.

Based on the analysis of the above four stages, the process of large-scale think tank DIIS research is shown in Figure 2.

In order to facilitate the practical operation of think tank research, we can summarize the process of large-scale think tank DIIS research into 14 steps (Table 2). Moreover, three inspection steps are adopted to ensure the comprehensiveness and scientificity of the research on issues. The corresponding relationship between each step and the large-scale DIIS research process is shown in Figure 3.

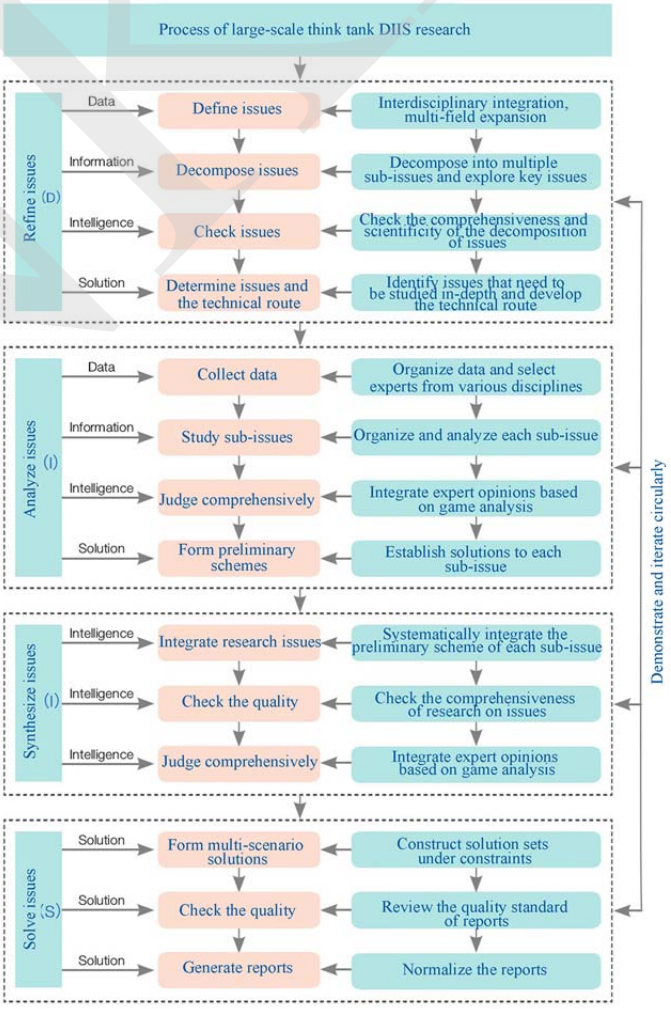

Figure 2 Flow chart of large-scale think tank DIIS research

Table 2 Steps of large-scale think tank DIIS research

Stage	Number	Step name	Details
Refine issues (Data)	Step 1	Define issues	Define the characteristics of research issues, focus on the relationship between various disciplines, and conduct interdisciplinary and multi-field research on issues
	Step 2	Decompose issues	Decompose issues into multiple sub-issues and explore key issues
	Step 3	Check issues	Check the comprehensiveness and scientificity of the decomposition of issues in Step 2. If the issue has been decomposed comprehensively, go to Step 4. If the issue has not been completely decomposed, return to Step 2 for re-decomposition
	Step 4	Determine issues and the technical route;	Determine the sub-issues to be studied in-depth, and form the basic technical route to solve problems
Analyze issues (Information)	Step 5	Collect data	Collect relevant data of each sub-issue
	Step 6	Study sub-issues	Organize and analyze relevant data of each sub-issue, and initially form an objective cognition
	Step 7	Judge sub-issues comprehensively	Synthesize the opinions of experts in related fields to conduct comprehensive judgment on each sub-issue
	Step 8	Form preliminary schemes	Based on the results of comprehensive judgment, the solution to each sub-issue is initially formed
Synthesize issues (Intelligence)	Step 9	Integrate research issues	Synthesize the solutions of each sub-issue initially formed in Step 8
	Step 10	Check the research	Check whether the integrated research results of Step 9 have solved the issue comprehensively. If the research is comprehensive, go to Step 11. If the issue is not comprehensively solved, return to Step 4 to demonstrate the research process circularly
	Step 11	Judge comprehensively	Benefit relevance analysis is carried out using methods such as uncertainty analysis and game theory, and problems are studied and judged comprehensively based on the opinions of experts
Solve issues (Solution)	Step 12	Form multi-scenario solutions	Construct various possible scenarios and conditions in the future, give solution sets under different scenarios and constraints, and form a preliminary report
	Step 13	Check the reports	According to the standard, the quality of the report is reviewed. If the quality standard is met, go to Step 14, namely that the report is generated. If the quality standard is not met, return to Step 1 to demonstrate the research process circularly
	Step 14	Generate reports	Generate the final compliance report according to the normalized format

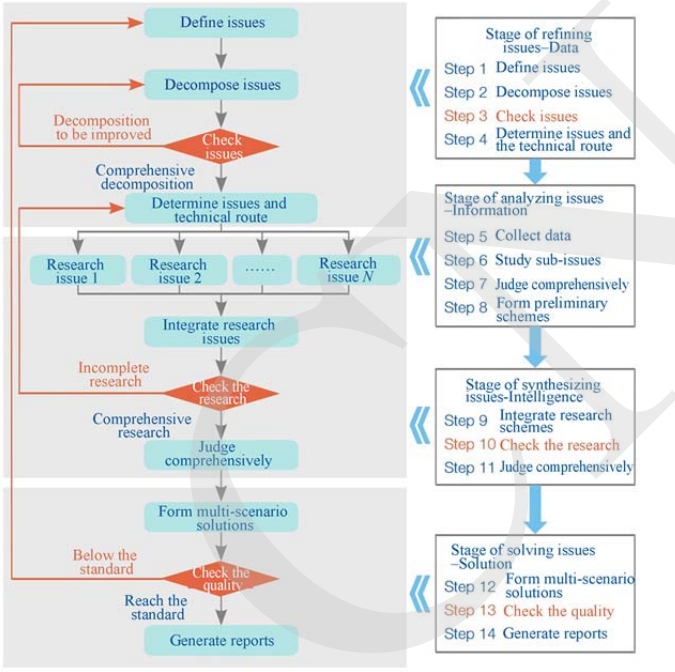

Figure 3 Flow chart for large-scale think tank DIIS research

2.2 DIIS theory and methodology for medium-scale think tank issues

The research objects of medium-scale think tank issues are relatively detailed, and the goal orientation is clear. The research can be carried out by a research group. Such issues are relatively specific, but still, need to be further refined. Finding key issues should be emphasized, and multiple feedback and demonstrations should be carried out. Therefore, when DIIS theory and methodology are used to carry out research on medium-scale think tank issues, the four links of the DIIS chain should be connected under the Problem orientation, Evidence orientation, and Science orientation and the Information and Intelligence of DIIS should be focused on. Specifically, for medium-scale think tank issues, DIIS research follows the process of four stages of clarifying requirements–analyzing key factors–demonstrating iteratively–drawing conclusions, which correspond to the four links of DIIS on the whole. The specific content of each stage is elaborated below.

(1) Stage of clarifying requirements: In the stage of clarifying requirements, the characteristics of research issues are analyzed in-depth and relevant requirements are identified. On the whole, the stage of clarifying requirements corresponds to the Data of DIIS theory and methodology, and the research idea of first analyzing issues and then determining requirements is followed. The specific process is as follows. ① Analyzing issues: Data information related to the research issues is collected, and the appeals of stakeholders (such as government, academic circles, industrial circles, and other interest institutions or groups) are identified. ② Determining requirements: Based on the relevant information on research issues, the goals, objects, and resource constraints of research issues are identified, and various requirements such as required experts, research methods, and tools are determined. Besides, the key nodes of various requirements are clarified, namely that the short-term, medium-term, and long-term requirements are determined.

(2) Stage of analyzing key factors: In the stage of analyzing key factors, based on the information of research issues

and the appeals of stakeholders, the challenges or obstacles to solving issues are determined, i.e., the key factors of the research issues. On the whole, the stage of analyzing key factors corresponds to the Information of DIIS, and the research idea of first focusing on the cause and then identifying the key is followed. The specific process is as follows. ① Focus on the cause: The relevant information on research issues and the appeals of stakeholders are integrated, and the rules and characteristics of issues are analyzed, thus finding the main cause or breakthrough of research issues. ② Identify the key: Based on the main cause of issues, the current situation and future development trend of issues are analyzed to determine the major challenges or obstacles affecting future development, and the decisive factors to overcome these obstacles are found (that is, to find key and core issues) to generate the preliminary solution to the issues.

(3) Stage of iterative demonstration: In the stage of iterative demonstration, the opinions of experts in related fields are systematically integrated, and the preliminary solution is repeatedly and circularly demonstrated and discussed for continuous iteration and sublimation. On the whole, the stage of iterative demonstration corresponds to the Intelligence of DIIS, and the research idea of first soliciting opinions and then repeating the demonstration is followed. The specific process is as follows. ① Solicit opinions: According to the results obtained in the previous stage, experts in related fields, technology strategy experts, policy-making experts, and personnel from relevant research departments are invited to give specific opinions. ② Repeat the demonstration: According to the opinions of expert groups, whether the issue is comprehensively studied is checked. If the research is comprehensive, a report is formed and the next stage is entered. If the issue is not completely solved, new information needs to be added for circular demonstration and repeated discussions.

(4) Stage of drawing conclusions: In the stage of drawing conclusions, the quality of the report formed in the previous stage is checked, and the research conclusions are obtained. On the whole, the stage of drawing conclusions corresponds to the Solution of DIIS, and the research idea of first checking the quality and then generating conclusions is followed. The specific process is as follows. ① Check the quality: According to the quality standard, the report formed in the previous stage is reviewed. If the quality standard is met, the next step is entered. If the standard is not met, the above research process is demonstrated circularly. ② Generate conclusions: The final report after the check is generated according to the normalized format, and the corresponding conclusion is given (the conclusion can also provide support for the research on large-scale think tank issues).

Based on the analysis of the above four stages, the process of medium-scale think tank DIIS research is shown in Figure 4.

In order to facilitate the practical operation of think tank research, we can summarize the process of medium-scale think tank DIIS research into eight steps (Table 3). Moreover, two inspection steps are adopted to ensure the comprehensiveness and scientificity of the research on issues. The corresponding relationship between each step and the medium-scale DIIS research process is shown in Figure 5.

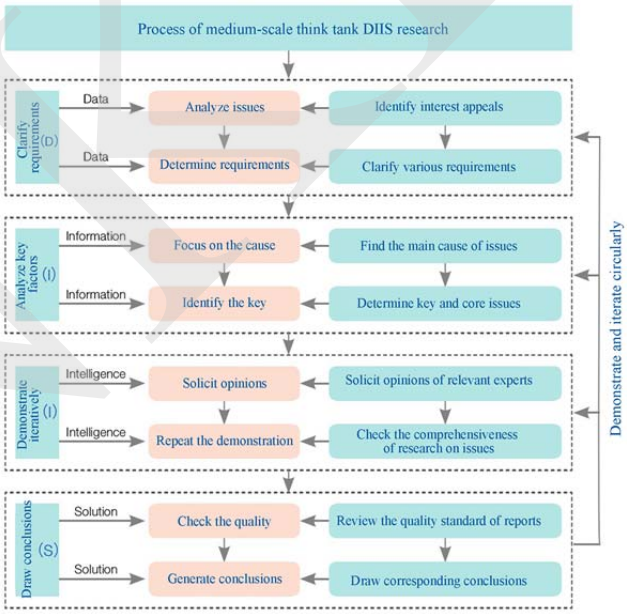

Figure 4 Flow chart of medium-scale think tank DIIS research

Table 3 Steps of medium-scale think tank DIIS research

Stage	Number	Step name	Details
Clarify requirements (Data)	Step 1	Analyze issues	Collect data information related to issues and identify appeals of stakeholders
	Step 2	Determine requirements	Identify various requirements of research issues and clarify key nodes of various requirements
Analyze key factors (Information)	Step 3	Focus on the cause	Analyze the rules and characteristics of issues and find the main cause or breakthrough of issues
	Step 4	Identify the key	Find key and core issues and generate the preliminary solution to key and core issues
Demonstrate iteratively (Intelligence)	Step 5	Solicit opinions	Invite relevant experts to give specific opinions on the preliminary solution
	Step 6	Repeat the demonstration	According to the opinions of experts in Step 5, whether the issue is comprehensively studied is checked. If the research is comprehensive, a report is generated, and go to Step 7. If the issue is not completely solved, return to Step 3 to demonstrate the research process circularly.
Draw conclusions (Solution)	Step 7	Check the quality	According to the quality standard, the quality of the report formed in the previous stage is reviewed. If the quality standard is met, go to Step 8. If the standard is not met, return to Step 1 to demonstrate the research process circularly.
	Step 8	Generate conclusions	Generate the final compliance report according to the normalized format, and give corresponding conclusions

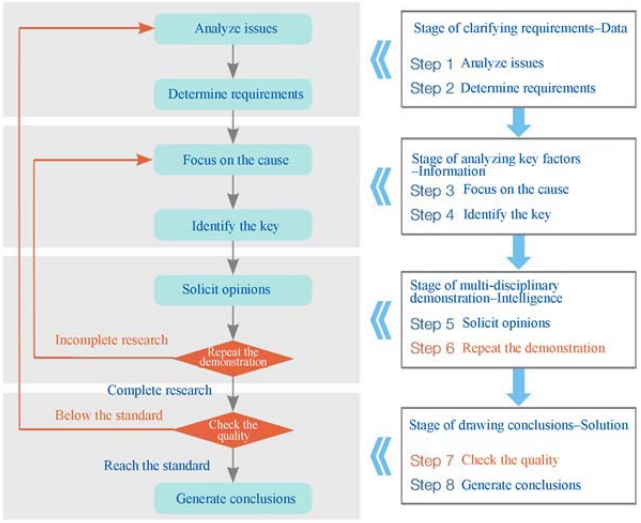

Figure 5 Flow chart for medium-scale think tank DIIS research

2.3 DIIS theory and methodology for small-scale think tank issues

Small-scale think tank issues usually have clear decision-making requirements and can be studied independently by research individuals. Such issues have clear research goals. The investigation of the research status of issues should be focused on and important information should be extracted. Therefore, when DIIS is used to carry out research on small-scale think tank issues, the four links of the DIIS chain should be connected under the Problem orientation, Evidence orientation, and Science orientation, and the Data and Information of DIIS should be focused on. Specifically, for small-scale think tank issues, DIIS research follows the process of four stages of investigating the current situation–extracting information–expert review–generating arguments, which correspond to the four links of DIIS on the whole. The specific content of each stage is elaborated below.

(1) Stage of investigating the current situation: In the stage of investigating the current situation, the domestic and international situation of the research issues is fully investigated. On the whole, the stage of investigating the current situation corresponds to the Data of DIIS theory and methodology, and the research idea of the domestic and international investigation carried out at the same time is followed. The specific process is as follows. ① Domestic investigation: Various ways are adopted to conduct a deep investigation on domestic materials related to the issues, including existing domestic research on the issues, main results, important advances, and relevant policies of the Chinese government, to clarify the domestic research status of the issues. ② International investigation: Various ways are adopted to conduct a deep investigation on international materials related to the issues, including the progress of international research on the issues, international development trends, and relevant policies of various countries, to clarify the international research status of the issues.

(2) Stage of extracting information: In the stage of extracting information, the existing gap is analyzed and the advantages and disadvantages of the research objects are identified by integrating domestic and international investigations. On the whole, the stage of extracting information corresponds to the Information of DIIS theory and methodology, and the research idea of first analyzing the current situation and then refining results is followed. The specific process is as follows. ① Analyze the current situation: Based on the domestic investigation, the status of research objects is evaluated, and then the international research status is combined to conduct a comparative analysis and find out the gaps and shortcomings. ② Refine the results: According to the research goals, the existing gaps and shortcomings are compared, and the advantages and disadvantages faced by the development of the research objects are summarized and analyzed. In addition, the main aspects that need to be improved and promoted are put forward, and the preliminary research results are generated accordingly.

(3) Stage of reviewing by experts: In the stage of reviewing by experts, experts in related fields are invited to review the preliminary research results, and suggestions are drawn from them for further deepening and improvement. On the whole, the stage of reviewing by experts corresponds to the Intelligence of DIIS theory and methodology, and the research idea of first reviewing and analyzing and then deepening and improving is followed. The specific process is as follows. ① Review and analysis: Experts in related fields are invited to review the preliminary research results, and comments and suggestions are obtained. ② Deepening and improving: The comments and suggestions are synthesized to check the research results, and whether the issue is comprehensively studied is checked. If the research is comprehensive, a report is formed and the next stage is entered. If the issue is not completely solved, relevant information needs to be supplemented to improve the research results.

(4) Stage of generating arguments: In the stage of generating arguments, the quality of the report formed in the previous stage is checked, and the arguments to solve the issues are obtained. On the whole, the stage of generating arguments corresponds to the Solution of DIIS theory and methodology, and the research idea of first checking the quality and then obtaining arguments is followed. The specific process is as follows. ① Check the quality: According to the standard, the quality of the report formed in the previous stage is reviewed. If the quality standard is met, the next step is entered. If the standard is not met, the above research process is demonstrated circularly. ② Obtain arguments: The final report after the check is generated according to the normalized format, and the supporting argument for solving the issues is given (the argument can also provide support for the research on medium-scale or large-scale think tank issues).

Based on the analysis of the above four stages, the process of small-scale think tank DIIS research is shown in Figure 6.

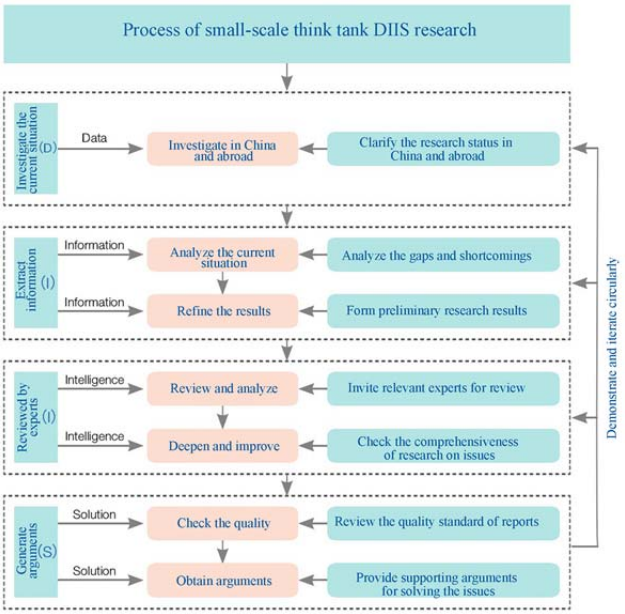

Figure 6 Flow chart of small-scale think tank DIIS research

In order to facilitate the practical operation of think tank research, this section summarizes the process of small-scale think tank DIIS research into seven steps (Table 4). Moreover, two inspection steps are adopted to ensure the comprehensiveness and scientificity of the research on issues. The corresponding relationship between each step and the small-scale DIIS research process is shown in Figure 7.

2.4 Relationship between think tank DIIS of different scales

In actual research, there is an internal connection between the research on think tank issues of different scales. This section analyzes the interrelationships among large-, medium-, and small-scale think tank DIIS research from the perspectives of research results and research process.

(1) Research results: Large-scale think tank issues are usually decomposed and studied by multiple research groups. Each research group further makes the research issues concrete and decomposes them into multiple sub-issues that are studied by research individuals. Therefore, the research results of the small-scale think tank DIIS can provide support for the medium- or large-scale think tank DIIS research, and the research results of the medium-scale think tank DIIS can provide support for the large-scale think tank DIIS research (Figure 8).

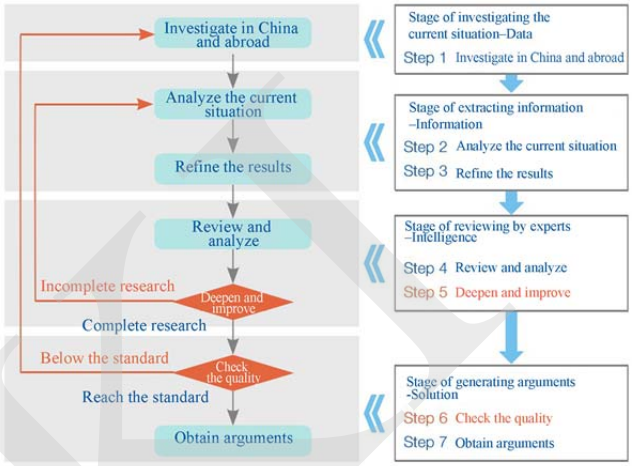

Figure 7 Flow chart for small-scale think tank DIIS research

Figure 8 Interrelationships of DIIS research on think tanks of different scales (from the perspective of research results)

Table 4 Steps of small-scale think tank DIIS research

Stage	Number	Step name	Details
Investigate the current situation (Data)	Step 1	Investigate in China and abroad	Conduct deep investigation on related domestic and international materials, and clarify the research status of the issues in China and abroad
Extract information (Information)	Step 2	Analyze the current situation	Analyze existing gaps based on international investigation and domestic research status
	Step 3	Refine the results	According to the research goals and the gaps, the main aspects that need to be improved and promoted are put forward and the preliminary research results are generated
Reviewed by experts (Intelligence)	Step 4	Review and analyze	Experts in related fields are invited to review the preliminary research results, and comments and suggestions are obtained
	Step 5	Deepen and improve	According to the comments in Step 4, whether the issue is comprehensively studied is checked. If the research is comprehensive, a report is generated and go to Step 6. If the issue is not comprehensively solved, return to Step 2 to demonstrate the research process circularly.
Generate arguments (Solution)	Step 6	Check the quality	According to the standard, the quality of the report is reviewed. If the quality standard is met, go to Step 7. If the quality standard is not met, return to Step 1 to demonstrate the research process circularly.
	Step 7	Obtain arguments	Generate the final report after the check according to the normalized format, and provide the supporting argument for solving the issues.

(2) Research process: From the perspective of the research process, the large-scale think tank DIIS research can be decomposed into multiple medium-scale think tank issues related to each other. For example, the second stage (stage of analyzing issues) of large-scale think tank DIIS research is to decompose the research issue into multiple sub-issues for research. These sub-issues can be regarded as the medium-scale think tank issues, thereby simplifying the issues and making the research on large-scale think tank issues concrete. Accordingly, the medium-scale think tank DIIS research can also be decomposed into multiple small-scale think tank issues related to each other. For example, the second stage (stage of analyzing key factors) of medium-scale think tank DIIS research is to find the main cause or breakthrough of the issue, which can be decomposed into multiple small-scale think tank issues. Through domestic and international investigations, the gaps are analyzed to find out the causes of the issues (Figure 9).

3 DIIS writing specifications of multi-scale think tank reports

The research report is a comprehensive explanation and demonstration of the research on think tank issues and reflects the main achievements of think tank research. In order to ensure the standardization and high quality of think tank research, the writing of think tank reports should follow certain writing specifications. Considering the differences in the focus of research on think tank issues of different scales, this section gives the DIIS writing specifications for think tank reports of different scales (Table 5). The think tank report generally consists of the cover, the brief introduction to the research, the explanation, the main body of the report, and others. The main body of the report follows different writing specifications for different scales of think tank research.

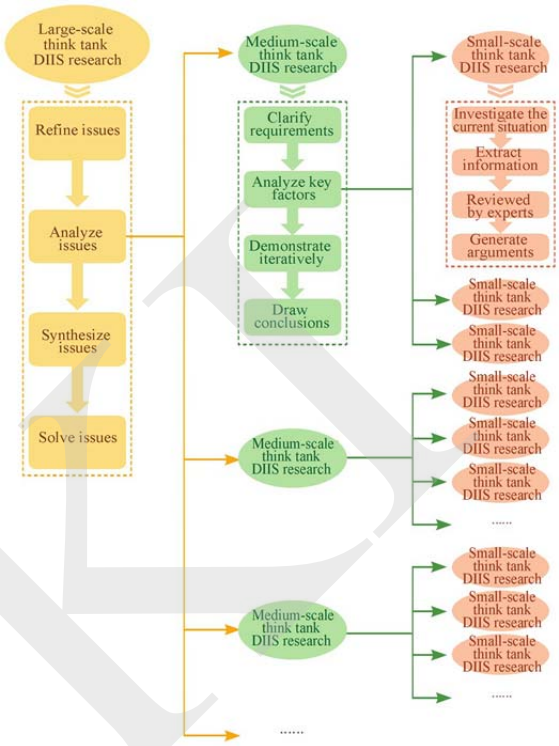

Figure 9 Interrelationships of DIIS research on think tanks of different scales (from the perspective of the research process)

Table 5 DIIS writing specifications of multi-scale think tank reports

Number	Title		Elements of writing
1	Cover		Research title, research topic, name, formulation time, distribution scope, and confidentiality level
2	Brief introduction of the research		Research issues, research abstracts, and research results
3	Explanation		Statement and authorization, contents, diagrams, and symbols
4	Main body of the report (Large-scale think tank report)	Refine issues (D)	Characteristics and requirements of issues, data sources, resource constraints, goals, routes, etc.
		Analyze issues (I)	Research contents, research schemes, research tools, research methods, etc.
		Synthesize issues (D)	Integrated results, comprehensive check, experts, schemes and methods for judgment, etc.
		Solve issues (S)	Solution sets of scenarios and research check
	Main body of the report (Medium-scale think tank report)	Clarify requirements (D)	Interest appeals, research objects and goals, resource constraints, specific needs, etc.
		Analyze key factors (I)	Rules of issues, main cause, existing challenges, key factors, preliminary solution, etc.
		Demonstrate iteratively (I)	Demonstration experts, demonstration schemes, demonstration methods, demonstration results, comprehensive check, etc.
		Draw conclusions (S)	Research check and main conclusions
	Main body of the report (Small-scale think tank report)	Investigate current situation (D)	Domestic current situation, international current situation, and data sources
		Extract information (I)	Existing gaps, remedial measures, research tools, research methods, preliminary results, etc.
		Reviewed by experts (I)	Review experts, review schemes, review methods, review results, comprehensive check, etc.
		Generate arguments (S)	Research check and main arguments
5	Others		Conclusions, research suggestions, references, and appendixes

4 Conclusions

In the process of advancing the modernization of the national governance system and governance capacity, it is urgent for think tanks to provide forward-looking advice and systematic solutions through scientific theories and methods. Combined with the research and practice of think tank issues, this paper deeply analyzes the main characteristics of large-, medium-, and small-scale think tank issues. Based on the DIIS theory and methodology of think tanks, this paper conducts in-depth research on the think tank issues of different scales and puts forward the DIIS research methods for large-scale think tank issues (refining issues–analyzing issues–synthesizing issues–solving issues), medium-scale think tank issues (clarifying requirements–analyzing key factors–iterative demonstration–drawing conclusions) and small-scale think tank issues (investigating current situation–extracting information–reviewing by experts–generating arguments). The paper also analyzes the interrelationship among large-, medium-, and small-scale think tank DIIS research from the perspectives of research results and research process. Finally, in order to ensure the standardization and high quality of think tank research, this paper gives the DIIS writing specifications for think tank reports of different scales.

References

1 Pan JF. 科技智库研究的 DIIS 理论方法. China Science Daily, 2017-01-09 (in Chinese).

2 Pan JF, Yang GL, Liu HH. DIIS theory and methodology in think tanks. Chinese Journal of Management Science, 2017, 25 (S): 1–14 (in Chinese).

3 Pan JF, Yang GL, Liu HH. DIIS methodology of science and technology assessment. Bulletin of Chinese Academy of Sciences, 2018, 33 (1): 68–75 (in Chinese).

4 Chinese Academy of Sciences. 科技革命与中国的现代化——关于中国面向 2050 年科技发展战略的思考. Beijing: Science Press, 2009 (in Chinese).

5 National Research Council. Sea Change: 2015–2025 Decadal Survey of Ocean Sciences. Washington, DC: The National Academies Press, 2015.

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