



# Research on Performance Evaluation Method for Science & Technology Innovation Group

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## ABSTRACT

Science and technology innovation group, which consists of technology innovation and knowledge innovation, plays an important role of national developing industry. With the rapid development of Chinese industry since the 21st century, higher and more urgent requirements for Chinese industrial scientific and technological innovation ability are put forward. Here we present a performance evaluation method for innovation groups, which includes evaluation index elements, descriptions, content and weighting factor, to focus on strengthening Chinese management innovation. The method can be used to evaluate scientific research management ability and innovation performance of science and research groups quantitatively. The evaluation results provide effective suggestions for improving the innovation ability and potentiality of research groups.

**Keywords :** *Performance evaluation, science & technology innovation group, technology innovation, innovation pattern.*

## 1. INTRODUCTION

In recent years, with the development of economy and the renewal of science and technology, the construction of China's industry has accelerated. They have greatly promoted the development and progress of modern human society. Establishing the science & technology innovation system, including technology innovation and knowledge innovation, is the inevitable requirement for a national independently developing industry. From the beginning of the 21st century, China industry have established many science & technology innovation groups and entities. As the research and manufacture technology have been evolved, the reality and the future of industry have put forward higher and more pressing requirements to its innovation ability and performance. Establishing and perfecting a science and technology innovation evaluation system of performance appraisal, suitable for China's reality and recent development requirement, have become important affairs to strengthen the management of innovation entities. This paper presents a performance evaluation method and an evaluation index system for science and technology innovation group. The method was applied on annual performance evaluation of some innovation entities and consulted the results with experts,

which could validate that the method is comprehensive and intuitive.

## 2. THE INDUSTRY INNOVATION SYSTEM OF SCIENCE AND TECHNOLOGY

Innovation, which is widely used nowadays, has several means and is interpreted differently for different occasions. As countable noun, an innovation is a new thing or a new method of doing something, and as uncountable noun, innovation is the introduction of new ideas, methods, or things, according to Collins Dictionary. It is normally considered that industry enterprise is typical technical innovation entities as market shows the innovation direction. Many governments have established kinds of innovation entities and formulated policing method to strengthen and to stimulate innovation ability. World leaders in the industries, such as America and Germany, all pay more and more attention to innovation abilities management and reinforcement, to adapt to the development of economy and technology nowadays. During the process of science and technology innovation establishment and development, solid and competitive industry is formed while the government, institution and enterprise all have played their respective roles and made contributions.

Science and technology research group is main force for technology development and innovation system construction of a country. We could divided science and technology research groups into four kinds, as government research center, enterprise research center, university study institute and other non-profit research group. Generally speaking, 30% of research and development work is done by US government research center, and 25% is done by university and college, as 40% is done by enterprise research groups and entities. Therefore, the research groups in enterprise and governments are formed as main force of research and development innovation power.

Government research center is major on national science research. In aviation study field, there are many government research centers of USA and EU, as NASA (National Aeronautics and Space Administration) of DOD in America, ONREA (The Office National d'Etudes et de Recherches Aérospatiales) of France, DLR (Deutsches Zentrum für Luft- und Raumfahrt) of Germany, NLR (Netherlands Aerospace Centre) of Netherland, INTA (Instituto Nacional de Técnica Aeroespacial) of Spain, etc. And also, there are TsAGI, CIAM, NIAT, SibNIA, VIAM, GFRI and other institutes in Russia.

Of all government research centers, national laboratory is the main force. As in America, a large amount of national laboratories and research centers are established by DOD (United States Department of Defense), Department of Energy and Department of Commerce, and are engaged in important, comprehensive and frontier research work. In addition, there are research organizations build by military, as DARPA (Defense Advanced Research Projects Agency) and AFRL (Air Force Research Laboratory).

Enterprise research centers, as research and develop center, innovation project group and other kinds of forms, are main force on technology innovation. By focusing on frontier, cross-cutting areas strongly related in main products and techniques, the enterprise research center could gain great science and technology achievements, which could help or build the foundation for company business development and product intergenerational upgrading[1].

Science research organization in enterprise usually according to mid and long term market needs, focus on main product development and key technology study, by cross-department and cross-field cooperation[2]. Take Skunk Works as an example, a large amount of technique experts from different industries are gathered together to construct unique and new concepts and innovation technologies. In Phantom Works, the main work is to prompt technology more mature and perfect for product development in 3 to 7 years, and to assess future and frontier technique prospectively. Safran Group in France particularly build research center for

key and common technologies, as simulation and modeling, material and production technique to upgrade the technological level of whole company. It can be seen from the development of foreign companies, that technology innovation is the key driving force of sustainable development. So, from this point of view, enterprise should build science and research department to improve the basic technology level. And also, enterprise could use its influence in the industry to spend more resource on science and research department, as product, technique and resources. The science and research department could relate the research work to the actual production to solve the problem of design and application[3][4].

Since university plays an irreplaceable role in basic theory and method study and research, there are many research institute build by university, or by university with government or cooperation together.

Non-profit research group is usually funded by government, as company, society, association or foundation, to leverage the network of industry, government, and academia partners to develop, demonstrate, and transition innovative technologies efficiently. Take The National Center for manufacturing Sciences (NCMS) as an example, which is a cross-industry technology development consortium, dedicated to improving the competitiveness and strength of the U.S. industrial base.

### **3.THE EVALUATION METHOD OF INNOVATION PERFORMANCE**

#### ***3.1.Purpose of evaluation***

Science and technology innovation group is the subject of technological innovation and scientific research innovation[5]. According to famous groups listed above, innovation group under good management would gain more resources for future development and also could help the development of the industry. In China, our national science and technology innovation structure is formed by government, enterprise, institution and university, technology innovation support system for many years[6]. There are many science and technology innovation groups, as Comprehensive National Science Center, State Key Laboratory, National Engineering Research Center, key laboratory founded by ministries, research center in companies, etc. And also, more kinds of innovation groups are formed during the development of country and society. By these groups operation in past decades, science and development management concept is formed and methods and theories on these groups' management and operation are studied to help the groups with more quality and quantity of achievements in scientific research[7][8].

The main objective of the evaluation method, based on analysis of the technology innovation process, could be divided in three aspects, the innovation input, innovation output and innovation ability. Based on these aspects, innovation groups would be evaluated periodically to stimulate its innovation ability, to improve the management method and to achieve better resource sharing.

**3.2. Main concept of evaluation**

Based on the characteristics of the system of China industry, the main concept of evaluation is that, according to group innovation ability data records, the evaluation results could be calculated by using an evaluation index system, as some of the scores are evaluated by experts.

**3.3. Evaluation system**

The evaluation system includes three parts: evaluation index system, index score calculation model, evaluation calculation system.

The focal point and difficult point to establish performance evaluation system is to design the evaluation index system. The evaluation index system consists four parts, which are evaluation requirements, evaluation index, examination content, index weight and

function value[9]. This index system could expounds the scope and focus of examination.

The index score calculation model is based on statistical data of group daily management or from financial and human resource department, as scientific research items, scientific payoffs, funding, professional and technical personnel. According to this model, the evaluation score of a certain group or several groups could be calculated.

**3.4. Application scope of evaluation**

This evaluation method is proposed for evaluation of innovation performance of research groups from industry key laboratory. There are two concepts in this evaluation method should be noted. The scientific research item is the scientific work at technology readiness level 1 to 6. The professional and technical personnel should be published by human resource department each year.

**3.5. Evaluation system**

In this paper, for efficient, quantitative and measurable evaluation, the principle and the way of constructing the index system are established through synthetically consideration, as listed.

Table 1 Evaluation index system

Evaluation Requirements	Evaluation Index	Description	Evaluation Content	
Technologies Prospective Research	Research Fields	The general standard of research fields	1. Prospective-ness and progressiveness of research fields.	
		chose by research groups.	2. Integrity of research fields.	
			3. Scientific of research fields.	
	Development Planning	Technology	The general standard of technology	4. Integrity of technology development planning contents.
			development plan made by research groups.	5. Implement-ation situation of technology development planning.

Evaluation Requirements	Evaluation Index	Description	Evaluation Content	
Management Ability	Construction Management System	The level of group's emphasis on daily management.	6. Regulatory of technology development plan making process.	
			7. Assigned the principle investigator. 8. Assigned the full-time management personnel.	
	Human Resource Management	The level of human resource management.	9. Personnel income level.	
			10. Personnel promotion situation in last evaluation time circle.	
			11. Staff training in last evaluation time circle.	
	Fund Management	Fund management situation	12. Efficiency in funds application.	
			13. Situation of funds outputs.	
			14. Situation of audit of funds.	
	Innovation Ability	Scientific Research Items	The situation of scientific research projects funded by various	15. The quantity per capita of scientific research projects.

Evaluation Requirements	Evaluation Index	Description	Evaluation Content
		organizations.	16. The funding per capita of scientific research projects.
	Scientific Research Instruments	The management and construction situation of scientific research instruments and platforms.	17. The value of scientific research instruments.  18. The utilizing ratio of expensive equipment and instruments.
	Achievements	The achievements in scientific research in group in recent years.	19. Scientific award from various organizations.  20. Number of patents possessed by group.  21. Publication of academic papers, research reports and technical standards.
Research Environment Construction	Talent	The talent team construction.	22. Evaluation the influence, superiority, pioneering ability of leaders and experts of group.
	Academic Environment	The excitement and professional level of group academic environment.	23. The situation of organizing, attending all kinds of academic conferences.  24. The situation of holding advanced lecture, scholarly meeting, academic exchange, group discussing, etc.

Evaluation Requirements	Evaluation Index	Description	Evaluation Content	
Satisfaction	Academic Impact		25. The situation of co-operation or collaboration with others on projects.	
		The academic influence of group inside and outside the industry, and the situation of opening and co-operation to other organization or groups.	26. The policy, mechanism and effects of talent introduction.	
			27. The policy, mechanism and effects of talents cultivation with others inside and outside the field.	
			28. The situation of academic exchange, as holding conferences and workshops, joint training courses, etc.	
	Customer Satisfaction		Overall satisfaction with the research projects from the funders.	29. The speed of the response.
				30. The accuracy of the response.
	Research Management Satisfaction		Overall satisfaction with the daily management of the research group.	31. The speed of the response.
				32. The accuracy of the response.

For such a performance evaluation index system involving many factors of objective factors and subjective factors, it is difficult to use quantitative mathematical methods for quantitative estimation and analysis. It can only be evaluated by a combination of qualitative and quantitative methods. The weighting factor is determined by the expert review team according to certain rules and procedures. Therefore, it is possible to quantitatively obtain the evaluation results of the innovation performance of research group.

Also, the weighting factor could be adjusted for changes of inner or outsider circumstances or

requirements. Company must continuously evaluated and modify its index system and evaluation process to ensure that the evaluation system can reflect the environment change and organizational goal.

#### 4.COMPREHENSIVE ANALYSIS EXAMPLE

To verify the evaluation method, we chose three research groups from certain research institution. Those groups all have undertaken scientific research tasks for a long time and have rich scientific research experience.

Data collection is carried out through scientific research task data collection, questionnaire surveys, and on-site investigations. Apply the evaluation method described in Section 3 to qualitatively evaluate the annual innovation performance of several research group in the research institution. According to the index system, there are 3 objective factors, as research fields, customer

satisfaction, and research management satisfaction, scored by experts and related organizations. And subjective factors are evaluated according to statistical data by certain weighting factor, determined by research management office of research institution. A comprehensive evaluation results can be obtained.

Table 2 Comprehensive evaluation results of 3 innovation groups

Evaluation Index	Weighting Factor	Group		
		A	B	C
Research Fields	5	4.8	4	2.9
Technology Development	10	10	10	10
Planning				
Management System	2	2	2	2
Construction				
Human Resource	6	2.4	4.2	2.4
Management				
Fund Management	2	2	2	2
Scientific Research Items	20	11	11.3	8.7
Scientific Research	5	5	5	5
Instruments				
Achievements	15	13.3	9	4.5
Talent	10	10	5	10
Academic Environment	4	2.9	4	2
Academic Impact	6	4.3	4	3
Customer Satisfaction	5	4.5	4.2	4
Research Management	10	10	9	7
Satisfaction				
<b>SUM</b>	<b>100</b>	<b>82.2</b>	<b>73.7</b>	<b>63.5</b>

It can be seen that for the annual innovation performance of 3 groups, group A has the best score, since it has well-chosen research fields, better research achievements in this year, great academic impact in its research field, and nearly perfect cooperation with customers and management office. Also, group B has its strengths, as good human resource management for staff future improvement plan, good score in scientific research items for funding, and great academic environment for innovation. From this evaluation results, group C could find its weakness and based on that draft improvement scheme for future.

## 5. CONCLUSIONS

This paper analyzes the characteristics of requirements of science and technology innovation group. A performance evaluation method for innovation groups is proposed with evaluation index elements, descriptions, content and weighting factor. By using this evaluation method, scientific research management ability and innovation performance of science and research groups could be evaluated and compared quantitatively and clearly. And research group could analyze results to improve the weak point in future. Science and technology innovation group is the future for every research institution. By evaluating the performance of research group, this evaluation system could help group to focus on management, to stimulate

group inner innovation ability, to rich management methods, and to accumulate more achievements, which could improve the innovation ability and potentiality of research group. In the future, the evaluation index system can be further enriched, and the evaluation mechanism for scientific research teams can be continuously improved.

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