

R&D project risk management research

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Abstract: after the 19th National Congress of the Party, with the acceleration of the construction of the new national infrastructure and the changing competitive situation of the market environment, the enterprises are challenged, which forces them to improve the R&D project management and improve the process effect and benefit. Among them, as an important part of controlling R&D project activities, project risk management has become a key concern. Therefore, risk management for R&D projects needs to be addressed through a series of measures to control risks, such as risk identification, risk evaluation, risk response and risk monitoring. Therefore, it is necessary to master its risk characteristics and target identification management points before studying R&D project risk management. In order to better identify and respond to the various risks in the project process.

1 Introduction

R&D (full name: Research And Development) refers to the creative activities of the system that need to use this knowledge to create new applications. its contents include three kinds of activities: basic research, applied research and experimental development. Risk management is helpful to improve the success rate of R&D projects and maximize the return on investment for high-tech enterprises. R&D project is the materialized embodiment of the three essential characteristics of innovation, science and technology and growth of high-tech enterprises. R&D activity is one of the main driving forces for the development of high-tech enterprises, and it plays an important role in the overall strategy of enterprises. At the same time, the management characteristics of high investment, high risk and high return require enterprises to operate every project seriously. Good risk management is a good guarantee for the success of R&D project and is conducive to the implementation and implementation of the development strategy of high-tech enterprises.

2 Characteristics and classification of R&D projects

2.1 Characteristics of R&D projects

R&D activity is a special type of productive labor, which has the characteristics of exploration, creativity, uncertainty and inheritance:

(1) Exploratory characteristics

R&D activities have the characteristics of exploring unknown fields, solving unsolved problems and finding solutions to problems, so any R&D activity is exploratory.

(2) Characteristics of creativity

The result of R&D activities is to create a variety of new knowledge (including new concepts, new ideas, new theories, new designs, new processes and new products), and new methods are the basic requirements of R&D activities.

(3) Characteristics of uncertainty

Exploratory and creative R&D activities determine their uncertainty characteristics. Since the success and failure of R&D activities are inevitable, there are considerable risks to R&D activities.

(4) Characteristics of inheritance

R&D activities are based on the knowledge and information accumulated by previous people, as well as the use of the scientific and technological system established by predecessors as one of the tools and foundations for further research, while continuing to explore the unfinished undertakings of predecessors and carry out basic research and development.

2.2 Classification of R&D projects

On the basis of the main contents of R&D activities, the types of R&D projects can be divided into three categories: improved R & D (Improvement Researcher and Development,I—R&D), innovative R & D (Creativity Researcher and Development,C—R&D) and basic R & D (Foundation Researcher and Development,F—R&D), etc. The specific contents are as follows:

(1) Improvement of R & D R&D projects

Improved R & D (I—R&D) refers to the study of reducing manufacturing costs by applying new knowledge and technology to improve the manufacturing process and methods of existing products. R&D projects to improve research and development are based on identified scientific and technological knowledge to improve or upgrade existing technologies. Because this task mainly involves the flexible application of existing knowledge, there is no mandatory requirement for the disclosure and application of new knowledge, and the technical risk is relatively low.

(2) Innovative R & D R&D projects

Innovative R & D (C—R&D) is based on basic research results and market demand, and actively adopts new materials and new designs to develop new products to meet the needs of the market or customers. Its essence is to meet the needs of new products, new drugs, new software and so on. The R&D project of innovative research and development is based on the existing scientific and technological theory, and finds new knowledge suitable for the goal through R&D activities in order to achieve the desired results. The essence of innovative R & D is to focus on discovering new technological advantages and actively seize the opportunity to transform these technologies into core competitive products.

(3) Basic R & D R&D projects

Basic R & D (F—R&D) refers to scientific and technological research in unknown fields. The purpose is to explore the basic principles of discovery or invention, acquisition of phenomena or observable facts, and to create new knowledge and theories that need to be actively realized through experiments or theoretical work. R&D projects of basic research and development not only explore the general laws of natural replacement and human social life activities, but also breed the changes and progress of science and technology, and promote the leap of human cognitive ability and productive forces. And for the progress of human social civilization has made a major contribution. Such studies usually do not have the purpose of its specific commercial nature, and most of the results are generally based on a wide range of truths, theories, or laws. For enterprises, the R&D projects of basic R & D are more or less related to the current or future business scope of enterprises, and most of them are oriented to the accumulation of knowledge and technology.

3 Main characteristics of R&D project risks

R&D project risk is similar to the general risk, it is an objective event that damages the enterprise value creation, which runs through every stage of the R&D project. The risk of R&D projects in high-tech enterprises mainly comes from the uncertainty of the research project itself, the inconsistency of the developer's ability, the difficulty and complexity of applying technology. These reasons make the risk of R&D projects in the process of progress more likely than ordinary projects. At

the same time, it may not meet the expected goals before the implementation of the project.

3.1 Objective existence of R&D project risks

Risk is an objective existence and is not transferred by individual will. Although it can not be fundamentally eliminated, the objective law of risk occurrence and development can be grasped in time through relevant scientific and technological means, and relevant countermeasures can be taken. Basically R&D activity is a process that can not be separated from continuous exploration and discovery, and the whole process is always faced with many uncertainties. This uncertainty is not only the source of the enterprise risk of high-tech enterprises, but also the vitality of this enterprise. As a result, the risk of R&D project is objective and can not be completely avoided.

3.2 Transitivity of the R&D project risk phase

R&D stage of the project determines that the later stage of the project must be based on the results of the previous stage. During the continuous advancement of the R&D project, the risk has a one-way transfer effect from front to back, that is, the risk factors of the previous stage may have an impact on the subsequent stage. With the stability of R&D project technology or the formation of products, many uncertainties will be gradually eliminated in the process of continuous progress of R&D projects. That is, as the project goes on, the uncertainty factors that lead to risk will gradually decrease. The rate and rate of uncertainty attenuation are affected by product category or technical difficulty.

3.3 Controllability of R&D project risk loss

Investment in R&D projects is a phased and continuous process. As a result, when a R&D project fails or terminates for a longer period of time, the related cumulative investment will increase more and more, and the resulting risk loss will increase accordingly. R&D project risk can be prevented to a certain extent, R&D activity is a purposeful, organized technical and economic activity, through strict organization and management, establish risk awareness, improve risk management measures, can prevent risk to a certain extent; R&D project risk is controllable, the risk that has an important impact on the success or failure of the R&D project can be controlled.

4 Key points for R&D project risk management objective identification and management

4.1 Management of R&D project establishment phase

The project stage mainly involves the feasibility analysis and project establishment before the formal development

of the project, and the feasibility analysis is mainly carried out from the technical and economic aspects. At this stage, if the project is not familiar with and understood enough, the feasibility analysis is not thorough, and the decision-making method is not scientific, the probability of project failure will

increase. According to the second national R&D resources inventory, we can see that the R&D project stage involves three aspects: basic research, applied research and experimental development. And these three aspects of funding is in a very large amount of investment.

Table 1: National second R&D resource investment

Indicators	The whole society	Enterprise	Industrial enterprises	Non-industrial enterprises	Research and Development Institutions	Institutions	Other
Basic research (10,000 yuan)	2702857	44182	23990	20192	1106276	1455112	97288
Applied research (10,000 yuan)	7307915	848165	529516	318648	3509107	2500292	450352
Pilot development (10,000 yuan)	48010294	41593683	37203607	4390077	5344098	726344	346169

Therefore, because the technical difficulty required for the R&D project can not be fully predicted and its own technical strength may be overestimated, the risk of failure of the project due to technical problems is high, while the economic aspect is due to too many uncertainties in the R&D project and too long R & D

cycle. If the expenditure and possible future income ratio of the whole R & D project can not be accurately estimated and the project budget is prepared in advance, it may have a negative impact on the normal operation of the enterprise. R&D project stage management points can be divided into several points:

Table 2: Management aspects of R&D project establishment phase

Level	Data
R&D project level (project)	
Objectives	Indicators (predictive accuracy)
Projected project expenditure	R&D costs
	R&D costs
	Projected profit
Projected unit product income	Pricing Strategy
Expected Product Sales	Product Basic Function

Therefore, according to Table 1, we can see that from the perspective of risk management, the goal of the enterprise is to maintain normal operation. To R&D project, it is necessary to accurately predict the expenditure of the project to prevent unnecessary financial loss to the enterprise in the subsequent stage; in the customer dimension, the project is only the "customer profitability" goal of the company we need to pay attention to. Internal operation process involves technical level judgment and project estimation time of enterprise R&D department.

The R & D phase is the most important stage from formal development to R & D completion. The R&D project can be divided into different stages according to the progress of the R&D project, and there are different technical requirements.

This phase corresponds to the project execution phase in the project life cycle. According to the second R&D project survey by the National Bureau of Statistics of China, there are many industries involved in the R & D phase of the R&D project.

4.2 Risk management R&D the R & D phase of the project

Table 3: Classification of National Second R&D Projects

Number of projects (projects) Number	Item (Project)(Item)	Project (project) full-time equivalent (person-year)
Agriculture, forestry, animal	2187	10606

husbandry, fisheries		
Mining	7191	63458
Manufacturing	184631	1153120
Production and supply of electricity, gas and water	2578	12489
Construction	6581	50376
Transport, warehousing and postal services	1164	4243
Information transmission, computer services and software industry	7113	69397
Finance	153	265
Leasing and business services	1648	17516
Scientific research, technical services and geological prospecting	69345	281609
Water, Environment and Public Facilities Management	496	1953
Education	451034	240900
Health, Social Security and Social Welfare	40869	93364
Culture, sports and recreation	326	880

Therefore, according to the number of projects (projects), it is necessary to implement specific indicators of R & D management: as shown in Table 2:

Table 2: R&D project development phase management indicators

Characteristics	Indicators
R&D expenditure	R&D costs
	R&D costs
	Cash flow requirements
Unit product profitability	Product cost
	Customer perception benefits
Customer conversion costs	Basic functions
	Derivative functions
	Unique features
	Complementary
R&D efficiency	New product launch probability
	Average R & D cycle
R&D investment strategy	Unique features
	Basic functions
	Derivative functions
R&D outputs	R&D quality
	R&D hours and total working hours Ratio

	Staff productivity
Project process	Employee Sense
Project staff	Core staff turnover rate
Patent law	Technology involves related patents

According to Table 2, it can be seen that from the point of view of risk control, the goal of this stage is to control the expenditure of R&D projects within the budget, and any excess expenditure is the source of risk. To complete the customer dimension needs to consider the relevant factors, affect the customer's choice in the previous market research to ensure that the product will not be significantly different from the customer's expectations after mass production, while ensuring that the company's products win more customers' favor. At this stage, the internal operation process should not only consider the efficiency and output of R&D projects, but also pay attention to the progress of technological breakthroughs. If the expected technological breakthrough can not be achieved, the investment strategy of the whole project needs to be revisited. In the dimension of learning and growth, it is the focus of this stage to prevent the departure of core technicians from causing project interruption and to ensure the stability of R & D personnel.

4.3 Risk management R&D the post-development phase of the project

From R & D completion to trial production to commercialization, the whole process of product life cycle is entered, which corresponds to the end stage of project life cycle, that is, the post-development stage. For the project team, on the one hand, it is necessary to organize the project materials, summarize the success or failure of the problem, transform the information obtained by the project into the knowledge assets of the enterprise, and prepare for the future project. On the other hand, it is to obtain customer and market feedback on the product, find out the existing problems, and make changes or adjustments if necessary. R&D specific post-development project management requirements are as follows:

Table 3: Management indicators for post-development phases of R&D projects

Objectives	Indicators
R&D expenditure	Total actual expenditure
Product benefits	Product sales
	Product cost
	Pricing Strategy
Market feedback	Design improvements
	Functional improvements
Mass production process	Technical support
After-sales service	Technical support
Project information	Technology access
	Technological breakthroughs
	Technical experience
Project staff	Core staff turnover rate
Company Law, Patent Law, etc	Design patents for technology

Therefore, through the indicators in Table 3, the factor supervision department needs to pay attention to the technical support and after-sales service needed in the production process to ensure the quality of the product. According to the second R&D project (project

of the National Bureau of Statistics of China, we can see the management of intellectual property rights of the main projects in the post-development stage of the R&D project.

Table 4 : Country second R&D activity output

R&D activities outputs	The whole society
Number of patent applications (cases)	363329
# Invention Application	154033

Number of effective invention patents (pieces)	246870
Transfer of patent ownership and licence (s)	307673
Patent ownership transfer and licensing income (10,000 yuan)	903345
Formation of national or industry standard (item)	27376
Published scientific papers (articles)	1423545
Publication of scientific and technological works (species)	49080

Therefore, the question that needs to be concerned is whether there is a violation of the laws promulgated by the countries such as the Consumer Rights and interests Protection Law, the Patent Law and the Anti-unfair Competition Law after the enterprise obtains the relevant patent through the purchase or application in the process of R & D project. Legal circumstances.

5 the method countermeasure of R&D project risk management based on performance orientation

The method of R&D project risk management based on performance-oriented is to use balanced scorecard and quality function to carry out R&D project risk management. It is a top-down approach that pays attention not only to the details of micro projects, but also to the risk management tools of corporate macro strategy. The whole risk management process is divided into seven steps:

5.1 Risk management objectives for constructing a balanced scorecard methodology

The balanced scorecard is usually used to formulate the overall strategy of the enterprise. R&D project goal is highly consistent with the overall strategy of the enterprise, and it is an important part of R&D project risk management through the development of four aspects: finance, customer, internal operation process and learning and growth. For example, the R&D efficiency problem considered from the perspective of enterprise strategy can be refined into the average R & D time, product qualification rate, average listing time and so on. It should be noted that the formulation of project objectives must conform to the company's own level of development and obtain the approval of relevant staff or technical personnel.

5.2 Active use of project objective evaluation indicators weights

Based on the balanced scorecard method, the importance of evaluation indicators depends on the correlation between indicators and R&D project objectives, which can be realized by relevant questionnaires, expert scoring and other methods. Moreover, in the process of establishing the weight of evaluation index, especially when determining the weight of evaluation index related to R&D product characteristics, the relevant information of competitors can be included on the premise of

receiving information channels. It is helpful to define the R & D goal of R&D project and reduce the market risk of products. At the same time, we can also compare the technical indicators similar to the competitors, and give appropriate weight to the indicators that can be optimized or improved, so as to improve the market competitiveness of the final products.

5.3 Setting risk indicators for R&D projects at all stages of implementation

R&D projects usually have the characteristics of phased implementation, R&D the results of each stage of the project will ultimately determine the success of the whole project. Therefore, from the point of view of risk management, it is very necessary to evaluate and control the risk of each relevant stage of the R&D project, to minimize the risk of the project, and to make it conform to the overall development strategy of the enterprise to the greatest extent. When making the risk evaluation index of the phased goal, the quality function expansion method is extended to the horizontal specific standard or related index to form the quality function expansion matrix. R&D the project is related to the outside world at a certain stage, in addition to the participation of the corresponding personnel in each stage of the R&D project, it also needs the relevant external personnel to participate in the whole process of establishing the index.

5.4 Evaluation of risk indicators for R&D projects through matrices

At present, the evaluation of R&D project risk index in the industry is simulated by triangle distribution. The risk measured by the R&D project index is defined as the possibility that the actual realization effect of the index does not reach the predetermined goal. Therefore, the risk index can be decomposed into :(1) the possible results ;(2) the impact of different results on the R&D project. Finally, the above formula (3) or (4) can be used to complete the evaluation of risk indicators. The risk identification and assessment phase often involves all aspects of risk, but for the risk management team, due to time, energy and resources constraints, it is too late to bring all risks into the scope of management. As a result, the risk management process should be orderly because it is very important for R&D projects.

5.5 Strengthening the risk level of monitoring R&D projects

Risk monitoring is a continuous process that runs through the entire R&D project. Risk monitoring can be

carried out by quantitative risk tracking diagrams. At each stage of the R & D project in the R&D project or at each specific time point, repeat the fourth and fifth steps above, determine the corresponding risk, and draw it on the same figure. This clearly shows the size of the risk and the effectiveness of risk control.

6 CONCLUSIONS

In general, the universal significance of risk management is that enterprises reduce risk losses to the minimum and achieve maximum safety and security through risk management. Therefore, through the analysis of R&D project risk management objective identification management key points, we can see the need to R&D the project establishment stage, the R&D project research and development stage and the R&D project research and development stage and other basic links management, through the performance-oriented R&D project risk management methods and countermeasures, can ensure the smooth progress of production and management activities and achieve business objectives.

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