

Study on the Mechanism of Project Integrated Risk Management for Technological Innovation Project

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Abstract: Technological innovation project is a kind of exploratory, creativity, competitive and strategic project with high cost and high risk. Taking technological innovation project as the subject and based on 6-step project risk management model, basic frame and factors – capability, resource and environment of project integrated risk management mechanism in the enterprise are stated, and the process and required measures are also analyzed in this paper.

Key words: technological innovation project; project integrated risk management; mechanism

□. INTRODUCTION

Innovation is the inexhaustible motive force for socio-economic development. With the development of knowledge economy and technological and economic globalization, national innovative capacity will play a key role to achieve social and economic development goals and innovation become a key factor to measure national competitiveness. As the cell of society and economy, enterprise is not only an integral part, but also the driving force of national innovation. Technological innovation of enterprises is the core of the enterprise innovation and the technical innovation projects can be described as the basis for the realization of technological innovation. However, technological innovation in enterprises does not isolate from business activities, it is the dynamic process affected by a number of internal and external factors. Because of inevitability of risk, project integrated risk management of technological innovation project will be explored in order to increase project success rate and improve the risk management for ensure the sustainability and stability of technological innovation.

□. PROBLEMS AND ISSUES

2.1 Technological Innovation Project in the Enterprise

Grasping potential market opportunities and seizing commercial interests as the goal, technological innovation is a series of integrated processes involving technological, organizational, commercial and financial activities, which including re-organization of production conditions and factors, establishment of more effective and efficient but low-cost production and management systems in order to launch new products, new production (process) approach, open up new markets, obtain new supply sources of raw materials or semi-finished products and create new business organizations.

As basic activity and the primary mean to achieve innovation, technological innovation project is the general investment project within product innovation and (or) process innovation for achieving industrialization of

technological fruit. Compared with the general activities of enterprises, technological innovation project is with the characteristics as systemic, cyclical, coordination.

2.2 Risk Factors Analysis of Technological Innovation Project

On the nature of technological innovation project, global technological innovation project practice show that the probability of failure is often greater than success. Because of experimental as the nature and its specific characteristics, there are a number of destabilizing factors and uncertainties involved in the various stages and aspects, so technological innovation activities are high-risk and with complexity of management. From different sources, risk factors of technological innovation project can be analyzed as follow:

(1) Project Resources

For enterprise, resources for project risk management is limited, especially critical resources, but as support conditions, the resources as human resources, material resources, financial resources, information resources and technology resources play a crucial role in the success of technical innovation project, while the lack of them will cause project risk.

(2) Project Capacity

Incompleteness of project information is an important cause of risk. Because of relatively limited capability in both the depth and breadth to understand, it is impossible to fully anticipate and understand the laws and consequences of various things associated with the project development and changes. Confined by finite cognitive ability, mistakes or errors in project management and decision-making must occur, and which is one of reasons to project risks. For the technological innovation projects in enterprise, the shortage in cognitive depth and breadth of following aspects could become risk source, and the capabilities to them will affect project risk management greatly. The project capacity is composed by technical capability, management capability and capital operation capacity.

(3) Project environment

Limited cognitive capacity and project information incompleteness is greatly caused by continuous development and changes of the project environment and objective issues, but these development and changes are mostly induced by people's arbitrary behavior and the changes of project constraints and assumptions. Projects are unique one-time and social activities, the environment and conditions which in must be full of constant evolving and changing, so the project risks result in the lagging of

management and decision making caused by the changes from objective and man-made factors, even if there are some recognitions about project environment and development could be hold by analyzing and forecasting in the stages as definitions and decision-making stage, design and plan stage and stage of implementation and control. For technological innovation projects, the risks mainly induced by the changes and developments from external environment include: policy risk, economic risks, market risks and social risks.

(4) Project Information

According to information science theory, the risk level depends on the information completeness, that is, how much the information about the objects that people have. Information science researchers believe that the incompleteness of project information is absolute, there will be a lot of risk events during the project implementation process, and information incompleteness is one of the roots of project risk. For technological innovation project, the information transmission and utilization must be focused in order to carry out risk management successfully. The operation and accomplishment of project risk management to related resource, capability and environment are based on the information, in other words, all of elements involved in the project induce risk in their ways, while risk management system realize its effects through collecting, tackling and analyzing and feedback information.

□ INTEGRATED RISK MANAGEMENT MECHANISM OF TECHNOLOGICAL INNOVATION PROJECT

Based on the above characteristics of technological innovation and risk causes analysis, it is necessary to create a comprehensive and systematic management mechanism in order to achieve efficient and

comprehensive risk management, and which should be continuous, parallel, iterative law during the full life cycle of the project and is conducive to grasp the dynamics of project risk and the continuity management goals, then the balance and optimization of the risk of the project life cycle can be achieved. Not isolated, there are complex interactions between the risk factors including the resources, the capacity, external environment and they affect the project in multidimensional system intertwined with time and space with the process of project. Therefore, combined with these factors, refer to the theory of system integrated, with specific objectives and function, risk management mechanism of technological innovation project will be established as follow.

3.1 The Concept of Project Integrated Risk Management

Known from the features of integrated management, integration emphasize on the functional comprehensive conformation of the linkages and the interaction of various elements constituted a system, in order to eliminate or reduce negative effects and give full play its positive role to system objectives. The project integrated risk management is to apply thinking of system integration for project risk management activities through optimization and integration of original elements and resources for overcoming the randomness and dispersion, thus the concept of risk management can be changed from "split" into "integrated" with overall dimension and process. Naiding Yang and Miller (2002), on the perspective of enterprise and project, built up the integrated risk management framework based on six basic modules and emphasized risk management objectives should be developed under the project goals, and then stated identifying, analyzing and evaluating of project risk during project life cycle and the way to carry out managerial tactics. Based on two dimensions, the project risk and

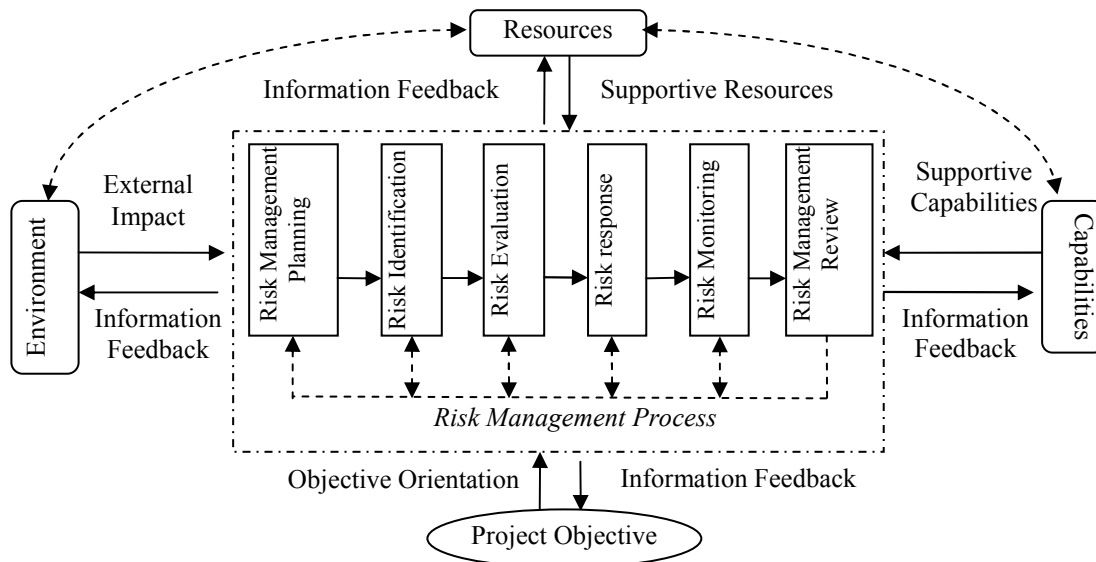


Figure 1. The frame of project integrated risk management mechanism for technological innovation project

uncertainty cost, An-bang Qi (2003) analyzed integrated management of project risk in detail. By applying the risk matrix, Qichao Zhu and Roberts (2005) filtered out the key risks and analyzed the impact of which to progress and cost. Nicos and Mottershead (2004) had research integrated risk management on the financial angle. In general, all studies have shown that the integrated risk management is based on comprehensive risk management theory and system thinking and refer to technique and methods of risk management to minimize the effect from risk factors and provide support to decision-making through effective configuration kinds of resources and select proper measures.

Creatively, combined with enterprise capability, resources and environment and information flow, a integrated risk management mechanism will be formed based on the a six-step risk management mode, which will take risk management department as the core during whole process of project management, and by organizational communication, collaboration, and the application of professional and efficient technologies and methods, all of project risks can be managed dynamically and effectively in order to enhance the success rate of innovation projects and maximize overall profits.

3.2 The Frame of Project Integrated Risk Management Mechanism for Technological Innovation Project

Based on six-step model of project risk management, the resource, capabilities, external environment and project objectives are integrated as the system elements and form the basic frame of project integrated risk management for technological innovation project. In this frame, project objectives are the guide of project implementation, which also orient risk management; the resources are the material supports and necessity to achieve project performance and implementation, the changes from external environment are the main way to affect project, the capabilities are as “soft power” to accomplish the coordination and organizing during project process. As the links between each step of risk management to other factors, the information will be the way to deliver the outcome for reflecting the situation of enterprise and environment. The mechanism stated in this paper is based a process model, each step of which is not only a sole part with specific function, but also a sub-system to affect the system as a whole. For each step, there are four parts involved: I (Inputs), which are oriented by project objectives and include the output from last step and other information; R (Resources), which can comprehensively reflect the situation and requirement of risk management on relative resource and capabilities T (Technique and Theory), the application and use of which is related with the capabilities in management; O (Output) is the outcomes from specific analysis and judgment, which can feedback in the form of information, so that the project integrated risk management can be a interactive and organic system. Separately, the content of each step is different according

to specific conditions and functions, though the fundamental structure of them are composed by four parts –inputs, outputs, supportive resources and techniques & theory showed in Figure 2.

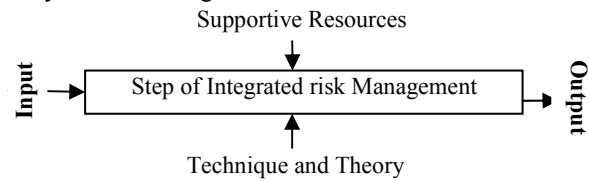


Figure 2. The element structure of risk management process

(1) Risk Management Planning

Risk management planning is a entire set of risk management plans for decision making of plans risk management activities and practice, which includes definition of project team members, risk management action plan and approach, selection of the appropriate risk management tools and criteria to evaluating risk. The results of the risk management planning are the strategic guidance of project risk management during the project life cycle. As a part of system, which is composed by the input, supportive resources, techniques and theories and the output, but because influenced by environment, enterprise resource conditions and enterprise risk management capabilities, there are some specific characteristics to project risk management planning, which is the basis of risk management and plays a key role in the project life cycle. (Details in Table 1)

(2) Risk Identification

In order to manage risk, clear understanding of the risks is necessity and with priority in whole risk management process. Risk identification is systematic analysis process to identify sources of risk, the conditions of risk occurrence, description of risk characteristics and appraising risk impacts, which can transform uncertainty of the project into understandable description. Risk identification process must rely on techniques and relative methods, such as check list, flow chart, brainstorming method, scenario analysis, Delphi method and SWOT analysis. As one of outputs of risk identification, event list can clearly show the events with negative or positive impact to the project. Risk source list is the output of further analysis to find causes of risk events. Based on two lists above, the risk symptom list is the comprehensive analysis of risk situation and can contribute to prevent and respond to risks. In general, the risks of technological innovation activities often include technology risk, market risk and financial risk, which from external circumstance, and the risks from the enterprise, such as strategic decision-making risk, research and development risk, organizational risk management and marketing management risks. The specific structure of this step is stated in Table 1.

(3) Risk Evaluation

In this step, a variety of operational risk data will be collected and analyzed by risk management personnel and relative experts after grasping qualitative information about project in last step. Also based on the system structure with input, resources and technical support, the outputs of risk evaluation usually include risk matrix, risk

Common measures of risk response Considering the resources, capabilities and external environment, enterprise can choose one or more measures for risk response, which commonly include risk avoidance, risk transfer, risk mitigation, risk retention and so on. Not the terminal but a part of risk management, this step also

Table 1. The process and structure of project integrated risk management of technological innovation project

Step	Input (I)	Supportive Resources (R)	Techniques & Theory(T)	Outputs(O)
Risk Management Planning	Project Objectives Project Requirements Evaluation of Project Resources Project Environmental Assessment Output of Project Risk Management Review	Personnel of Risk Management Planning Material of Risk Management Planning Fund of Risk Management Planning Information of Risk Management Planning Organization Risk Management Planning	Meetings of Risk Management Planning Risk Database Criteria or index system of Risk Evaluation	Plans of Risk Management Estimation of Risk Situation and Trend Plans of Risk Aversion
Risk Identification	Project Objectives Output of Project Risk Management Planning Project Risk Experience	Personnel of Risk Identification Material of Risk Identification Fund of Risk Identification Information of Risk Identification Organization of Risk Identification	Information Collection Technologies Risk Database Assumption Analysis Chart Analysis	List of risk events Risk source list Risk symptoms list
Risk Evaluation	Project Objectives Output of Project Risk Identification Standard and Criteria of Risk Evaluation	Personnel of Risk Evaluation Material of Risk Evaluation Fund of Risk Evaluation Information of Risk Evaluation Organization of Risk Evaluation	Risk Database Monte Carlo Analysis Decision Tree Analysis AHP	Risk matrix Risk Extent List Risk Comprehensive Evaluation Risk Correlation Analysis
Risk Response	Project Objectives Output of Project Risk Evaluation Measures and Tactics of Risk Management	Personnel of Risk Response Material of Risk Response Fund of Risk Response Information of Risk Response Organization Risk Response	Risk Database Response Plans of Risk Response Responsibility Matrix of Risk Response	List of Residual Risks List of Handled Risks List of Non-Handled Risks
Risk Monitoring	Project Objectives Output of Project Risk Response Project Risk Management Plans	Personnel of Risk Monitoring Material of Risk Monitoring Fund of Risk Monitoring Information of Risk Monitoring Organization of Risk Monitoring	Risk Database Audit Test Monitoring Sheet Cost Deviation Analysis	Risk Monitoring Report Risk Management Performance Report
Risk Management Review	Project Objectives Output of Project Risk Monitoring Cost Report of Project Risk Management Project Risk Management Plans	Personnel of Risk Management Review Materials of Risk Management Review Fund of Risk Management Review Information of Risk Management Review Organization of Risk Management Review	Risk Database Value Engineering Personnel Performance Assessment	Review Report of Risk Management Effectiveness Review Report of Risk Response Effectiveness Evaluation of Risk Management Capabilities

extent list, risk comprehensive evaluation, risk correlation analysis. In risk matrix, the situations of various risks will be segmented and described in detail. And focus risk can be found by some specific methods, such as break-even analysis, AHP, fuzzy comprehensive evaluation method, sensitivity analysis, Monte Carlo analysis, decision tree analysis, which is the input of next step and provides evidence to select appropriate risk response measures. (Details in Table 1)

(4) Risk Response

According to the outputs of risk identification and risk evaluation, the most effective and appropriate measures to handle specific risk will be selected and implement. As the core of this step, approaches to face risk are selected based on the information about risk probabilities and seriousness from project risk identification, estimation and evaluation, then which measures will be carried out and what the effects should be achieved can be determined in this step.

composed by input, resources, techniques and outputs showed in Table 1.

(5) Risk Monitoring

On the one hand, risk monitoring is the tracking of identified risks, monitoring residual risks, identifying unknown risks; on the other hand, it is to ensure the practice and implementation of risk management plans and the plans of risk response. The procedure of project risk monitoring is continuous through the whole project life cycle. During the process of monitoring, all of relative team members of project should communicate regularly in order to re-evaluate the situation of project risk and the effects of risk response. Risk monitoring can provide relevant information to help us make effective decision-making before risks occur and prevent risks, the specific methods in this step are audit test, monitoring sheet, cost deviation analysis and so on.

(6) Risk Management Review

Different from other risk management, due to technical innovation is a continuous learning process in essence, including the accumulation of risk management knowledge and experience, the quality and quantity of knowledge for enterprise management is progressive. Therefore, enterprises should focus on the effectiveness and efficiency of risk management, evaluate the effectiveness of risk management in order to accumulate experience and improve risk management in further. Because of many factors, such as leadership style and management attitudes, the risk management cost is usually without enough attention, but in the step named risk management review, which is the final link of integrated risk management and the output of which will be one of the most important inputs to next project risk management, risk management cost can be involved to analyze the performance of risk management. For example, refer to the concept of value engineering, the risk management effect (E), which is the loss avoided and risk management cost (C) can explain the performance of risk management by building up utility engineering: $U=E/C$. Emphasizing on outcome of unit cost, if $U > 1$, the risk management is effective, if $U < 1$, the risk management is not effective, and the value of U is greater the more effective risk management is.

□ CONCLUSION

As a strategic activity, technological innovation project can improve the core capability and contribute to the growth of enterprise. But because of the impacts from external environment, and the limitation of information and recognition make the project with various risks and hard to manage by common method. So a project integrated risk management mechanism for this kind of project had been put forward in this paper, which associated with capabilities, resource, environment and project objective and based on a six-step risk management model, and by setting appropriate objective system, management organization and specific information system, it can provide a useful reference for improving risk management of technological innovation project.

Furthermore, there some key issues must be pay more attention to establish this mechanism:

(1) Project Objective Setting

As the guide and orientation, project objective is also throughout the risk integrated management. Therefore, exact and accurate project objectives definition is not only to effect the implementation of the project risk management, but also directly relates to the success of the project. As for technological innovation projects, the objectives are more important because of the high-input, high-risk, and even change induced by it. Therefore, the objective of technological innovation project is not only a comprehensive index, but a subsystem as an important component of enterprise risk management. Under the guidance of project positioning and the corporate strategy, a general objective should be laid down, and then the sub-

objective of each management activity can be set by breakdown of general objective according to the organization structure and management factors.

(2) Management organization

Effective risk management activities to be implemented through appropriate organizations, so the enterprises should establish appropriate risk management institutions. Traditional enterprise risk management organizations are formed on the basis of repetitive process, but the organization to implement integrated risk management of technological innovation project should be project-based, cross-functional dynamic and flexible. At the same time, the project integrated management of risk requires that senior corporate managers must support and participation and undertake certain responsibility.

(3) Risk Management Information System

Risks arising from the incompleteness of information, so the whole information process must be optimized in order to establish and optimize the project integrated risk management system, which can send the right information to staff at the right time (Project Critical Point). Including management information generation, collection, processing and sending, the risk management associates with information management and integrated risk management is inseparable from information systems integration. Generally speaking, the information involved in integrated risk management includes: managerial supportive information of risk management theories, policy information, information about external support and the feedback information of implementation of risk management.

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