The Analysis and Estimation on Risk Factors in Engineering Project Life-cycle

Zou Wen-ping [1]
1. Transportation College,
Fujian Agriculture and Forestry University
Fuzhou 350008, China
zouwenp@163.com

Lin-li[1,2,3]
1. Transportation College,
Fujian Agriculture and Forestry University
Fuzhou 350008, China
2. Civil Engineering College,
Fuzhou University
Fuzhou 350108, China
3. Key Laboratory of Highway Engineering (Changsha University of Science & Technology), Ministry of Education
Changsha 410076 , P.R.China
fjlinlill@sina.com

Abstract—**In recent years the engineering accidents, especially those occurred to large-scale public projects were paid more and more attention by engineers and even the normal public. The large-scale public projects involved such numbers of participants and complicated procedures, which challenge to the traditional project security management. There is should be anew method to do with the modern engineering's risk manage requirement. This article summarized the risk factors in all the engineering process as the risk theoretical research foundation. In this paper, considering the disadvantages of disseverment and isolation each engineering process stages of traditional engineering risk management method, the idea of project's life-cycle method is introduced in the risk analysis for improvement the traditional disadvantage. This article also shows how to determine the risk sources and the risk liability by analyzed the stages' risk possibility of project life-cycle. These works will help to build up an analysis basement for engineering risk control research.**

Keywords-risk management; project life-cycle, risk source; risk factor

I. INTRODUCTION

In recent years, with the project accidents continually come into the public view, the engineering risk management and control studies become hot. Especially the large-scale public projects need the more comprehensive and scientific method to meet the higher engineering safety requirements. Traditional engineering risk research always separate each project stages or independent each participants. This approach makes the discussion of engineering risk and accident responsibility base on separating the relationship within engineering stages. It induced so many significant limitations in the engineering risk macro-assessment and micro – control and will not in accordance with the laws of science.

The whole project implementation is actually an interaction of many different works. Many experiences of accident investigations have already proved the close relationship within project's stages. Therefore, the project whole life-cycle concept was introduced into the project risk management. Basing on it, to control the project risk level by manage the various risk factors in different stages of project life-cycle. This idea helps to determine the risk from a macro level and then disturb the risk factors and prevent the risk pipeline for increasing the risk control ability. It will be more effective, objective and comprehensive than traditional risk management method.

Project life-cycle management is an advanced idea. Base on it, the whole project live was taken as a systematic process, and fully taken into account the project interaction of all stages [1]. However, life-cycle risk analysis is not yet a mature development method. Today it has not established a widely acceptable concept and specific implementation system. To create more accurate project life-cycle risk analysis methods, the first thing is to be done is the comprehensive investigation of the project life-cycle risk sources and the related risk responsibility. On this investigation achievement to establish the risk factors bank and then identify the possible risk. This meaningful work of engineering risk sources estimation and risk factors investigation will help to establish a better analysis basement for further research on engineering project's whole life-cycle risk management to establish a good analysis platform.

II. RISK STAGE COMPARTMENTALIZATION AND RISK SOURCE ANALYSIS IN ENGINEERING PROJECT'S LIFE-CYCLE

The whole process of engineering project is comprehensive. Each stages is not absolutely independent, on the contrary the Interaction is very close. In order to facilitate research work, the project life-cycle process is divided into six brief stages according to the general project order, which including project establishment, design, budget estimate and bidding, construction, operation and maintenance, and scrap demolition. The risk factors of the six stages were defined r_1, r_2, r_3, r_4, r_5, r_6, like figure 1.

It can be seen from the figure 1 that all the project stages are independent and interrelated. The risk sources of any stages may induce the accident in other life-cycle stages. But the different participants take the different responsibility in various project stages. So it is necessary to analyze and identify the risk sources of each project stage during the whole life-cycle of engineering. The risk sources and corresponding responsibility

The project was supported by Open Fund of the Key Laboratory of Highway Engineering (Changsha University of Science & Technology), Ministry of Education

978-1-4244-5326-9/10/$26.00 ©2010 IEEE

for the stages' accident were analyzed according to the project carried out order as figure 1:

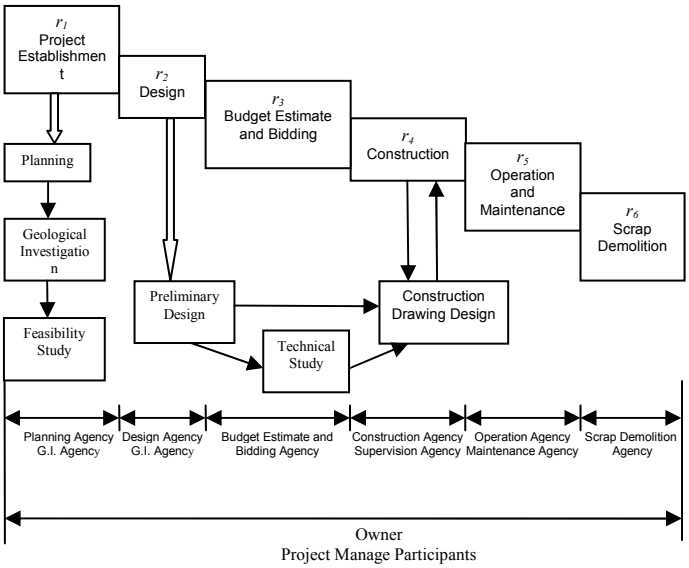

Figure 1. Whole Life-cycle of Engineering

A. Risk Factor of Project Establishment Sstage r_1

Project establishment is the beginning of an engineering project mainly including planning, geotechnical investigation for construction site and engineering feasibility study.[2][3][4] The accidents risk sources may exist in this project stage are:

1) Bad planning risks;

2) The accuracy risk of the exploration to geological conditions;

3) The accuracy risk of the feasibility study;

4) The risk of false profits or benefit.

All the risks come from project establishment stage. This kind of risk is hidden in the dark and the lose of the risk is huge. Especially the lose of some large scale public project is be assume by all the society [5]. However, as the source of all the stage risk, the project establishment stage is always ignored in the actual engineering practice. it is not in accordance with the engineering law.

B. Risk Factor of Design Stage r_2

In design stage faces to the risk including design theory, the calculation model, calculation and analysis capability. Especially for some demanding projects which have new systems, new structures, new materials, a large span, deep-sea basement, or some particularly construction sites and some other factors hard to control, their design risks are especially in evident.

1) Risk of employ the design agencies;

2) Technology risk like design idea and the selection of the risk calculation model;

3) Risk of premature development of design theory.

The design stage is a risk-fully stage and one of the most common source of engineering accident risk. It also is the risk source which will lead to irreparable major accidents and loss. Therefore, the surveillance and audit to the design agencies and design methods at the design stage is necessary. The methods such as improvement of the design responsibility laws, implement effective design accountability in all life of engineer and offer some design bail according to project will help to reduce the design risk.

C. risk factor of budget estimate and bidding stage r_3

Before construction the owner will select the construction company basing on the budget estimates. The owner and construction company will restrain each other to balance the interests and rights .by contract. There are still some risks:

1) accuracy risk of budgetary estimate;

2) bidding risk;

3) risk of contract is reasonable or not

4) Schedule risk.

Project bidding as the last stage before the project constructed make a more accurate budget, scientific bidding, detailed engineering contracts and regulate each participant's responsibilities and obligations. It is the most important guarantee for engineering project's going on. It should be pay more attention that in this stage the core risk is the contrast and bidding risk.

D. risk factor of construction stage r_4

Construction stage has the most participants and it also is the most dangerous stage. The construction accident always is most familiar to engineers and the traditional engineering risk concern mainly about the risk of construction period, which including:

1) Man-made disaster risk;

2) Construction technical risk;

3) Construction environmental Risk;

4) Accidents risk caused by natural disasters.

Engineering accident analysis should pay special attention to the risk sources and accident responsibility of this stage because the inappropriate construction or improper material selection is often become the accident inducement root cause. The reason of the construction risk is not always single one which should be detailed analyzed, or even determined by field experiments.

E. risk factor of operation and maintenance stage r_5

The life stages of project after completion check and acceptance and then delivery to owner until discard as useless is called operation and maintenance stage. In the traditional conception, the risk of operation and maintenance stage does not belong to the engineering risk, or take this stage risk independence and has nothing to do with other stages. The fact is that project life cycle is an organic system. There are more risk inherit from pre-stages than which was produced in the stage itself. Most accident occurred in the operation and maintenance stage is often a multi-factor complex [6]. The complex reasons formed the dangerous chain and then eventually leading to accidents. These risk sources are mainly including:

1) Self-borne risks

a) Operational management risk

b) Undue maintenance risk

2) Inherited risk which is the risk during the operational caused by improper planning, design and construction works.

Most of the accident in the operation stage is the results of self-borne risks and inherited risk composite action. Therefore the operational accident analysis should pay more attention to the hidden factors for tracing the source of the accident and fundamental.

F. Risk factor of crap and demolition r_6

The final stage of project lifecycle is scrap and demolition which stage risk is seldom to be considered in the risk management. However the impartial and objective engineering accident risk analysis should have to consider the all lifecycle risk. Obviously this final stage should be taken into account for complete the risk chain. The risks in this stage include:

1) Technical difficulty risk of crap and demolition;

2) Risk of human error;

3) Environmental risk of the project implementation

There is a typical accident case. In May 2009, a viaduct was going to be removed suddenly collapsed in Hunan province, resulting in nine people were killed and 16 wounded at the moment. The causes of this bridge collapse accident happened during the demolish stage includes: technical errors of removal design, lack of sufficient safety demonstration and risk assessment, there is no corresponding contingency plans, no real-time monitoring, the contractor of removal engineer without the corresponding qualification, and there is even not closed engineering environment, and so on. The all typical accident risk factors were involved in this disaster.

III. ANALYSIS ON THE ACCIDENT RISK INFLUENCE FACTORS

The all influences to project lifecycle come from the owners, the administrative departments, planning agencies, geological survey department, design department, budget agency, the construction units, supervision departments, operating agencies, maintenance departments, removal units, and other participants. To divide the risk factors contribution degree from every participants involved in all project stages into four grades: Ⅰ is great impact, Ⅱ is moderate impact, Ⅲ is smaller impact, Ⅳ is basically no impact. Now list the impact degree as table Ⅰ.

Figured from the all lifecycle risk factors contribute table, the engineering risk of each stages were composed by many factors. Especially the owner, administrative departments, and planning agencies which have great influence to the engineering lifecycle risk and ignored by most of time. This is so different to the traditional risk manage idea. So the advanced risk management should pay more attention to these departments and control the risk from them in engineering all lifecycle.

TABLE Ⅰ. PROJECT LIFE-CYCLE STAGES RISK IMPACT FACTORS

Project Participants	Engineering Project Stage Risk					
	r_1	r_2	r_3	r_4	r_5	r_6
Owner	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ
Administrative Department	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅰ
Planning Agency	Ⅰ	Ⅱ	Ⅱ	Ⅱ	Ⅱ	Ⅱ
Geological Survey Agency	Ⅰ	Ⅰ	Ⅰ	Ⅰ	Ⅱ	Ⅱ
Design Agency	Ⅱ	Ⅰ	Ⅰ	Ⅰ	Ⅱ	Ⅱ
Budget and Bidding Agency	Ⅱ	Ⅱ	Ⅰ	Ⅰ	Ⅲ	Ⅲ
Construction Agency	Ⅳ	Ⅳ	Ⅰ	Ⅰ	Ⅲ	Ⅲ
Supervision Agency	Ⅳ	Ⅳ	Ⅳ	Ⅰ	Ⅲ	Ⅲ
Operation Agency	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅰ	Ⅲ
Maintenance Agency	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅰ	Ⅱ
Scrap Demolition Agency	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅳ	Ⅰ

IV. CONCLUSIONS

The risk can be inherited by follow-up stages, and the mistakes and errors of prophase will become the potential risk source of post phase. So the risk relationship within the stages should be considered objectively. In this paper the risk influence factors of all engineering process were analyzed basing on the conception of engineering project lifecycle to be the basic study for engineering accident risk research. At the same time the risk influence contribution from each participant was analyzed, especially the upper departments like owners, administrative departments, and planning agencies, design department and so on donate the most risk to all engineering lifecycle. The greatest risk contribution departments have so many chance to be the instigator of engineering accidents. More attention should be paid to them.

REFERENCES

[1] Benjamin Matthews, Jonathan R. Sylvie, and Sang-Hoon Lee. "Addressing Security in Early Stages of Project Life Cycle." Journal of Management in Engineeting, ASCE, 10,196-202, 2006.

[2] Construction Industry Institute(CII). "Alignment during preproject planning." *IR 113-3*, Austin, Tex,1997.

[3] Construction Industry Institute (CII). "Planning for Startup." *IR 121-2*, Austin, Tex,1998.

[4] Griffith, A. F., and Gibson, G. E.,Jr. "Alignment during pre-project planning." J. Manage. Eng., 17(2), 69–76, 2001.

[5] Construction Industry Institute (CII). "Design effectiveness." *RS8-1*, Austin, Tex, 1986.

[6] Little, R., Meacham, B., and Smilowitz, R. "A performance-based multiobjective decision framework for security and natural hazard mitigation." *Proc., National Symp. on Comprehensive Force Protection*, Society of American Military Engineers, Alexandria, Va, 2002.