

# Analysis of Ethical Responsibilities in Engineering Risks

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## Abstract

Nowadays, China's engineering development is getting faster and faster, and the engineering volume is rising year by year, and the engineering activities are affected by various uncertainties, which leads to the frequent occurrence of engineering accidents in China. In order to reduce the occurrence of such engineering accidents, we must clarify the responsibilities of all parties related to engineering to reduce the uncertainties brought by engineering risks. In this paper, we first analyze engineering risks and ethical responsibilities to study the causes of engineering risks, and analyze the ethical responsibilities existing in them from the perspective of these engineering risks, and divide the responsible parties who mainly bear ethical responsibilities in engineering risks, and finally propose action strategies for effective prevention of engineering risks for the responsible parties.

## Keywords

Engineering Risks; Ethical Responsibilities; Engineering Ethics.

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## 1. Introduction

### 1.1 Research Background

Since the 18th National Congress, China has accelerated the construction of the project, the rapid development of the project has not only brought huge economic benefits to China, for example, the total construction project value rose from 121,719,992 million yuan to 25,920,409 million yuan between 2012 and 2021[1], while also providing a large number of jobs for our residents and promoting employment, as far as the number of people employed in housing construction is concerned. During the period from 2012 to 2021, the number of employment rose from 546,393 to 1054,774[2]. Engineering construction in general drives the overall development of China's economy, society, and overall national power. Because engineering projects often have a long time, high investment, and high technical requirements, they are subject to many uncertainties in the process of implementation, so all parties participating in engineering projects will inevitably face a variety of engineering risks.

### 1.2 Research Significance

Nowadays, China's engineering development is getting faster and faster, the volume of engineering works is rising year by year, and engineering activities are influenced by various uncertainties, which leads to the frequent occurrence of engineering accidents in China. For example, in Zhangjiakou City, Hebei Province, Wangshan Circular Economy Park, near Hebei Shenghua Chemical Co., Ltd, an explosion occurred at 0:40 on November 28, 2018, resulting in 23 deaths, 22 injuries and heavy property damage. The occurrence of such engineering accidents deserves our deep thoughts, and in order to reduce the occurrence of such engineering accidents, we must clarify the responsibilities of all parties of the project to reduce the uncertainty caused by engineering risks.

### 1.3 Current Status of Domestic and International Research

#### 1.3.1 Status of Foreign Research

##### (1) Research on engineering risks

Risk-related theory was first proposed by American scholar Vittore in 1901, who put forward three levels of risk: the objective existence of risk, the uncertainty of risk and the subjective nature of people wanting to avoid risk[3]. In 1980, German sociologist Ulrich Beck put forward the theory of risk society, and he believed that the causes of risk are multifaceted. 1983, American scholar Mike W. Marti and others published *Engineering Ethics*, in which Martin argued that engineering technology improves people's lives on the one hand, and there are huge engineering risks on the other. 2013[4] Ali AL Johani Ahmed et al. studied some engineering risks in society and put forward relevant suggestions to avoid various risks. With the frequent occurrence of engineering accidents, some foreign scholars started to analyze the causes that lead to the occurrence of engineering risks. 2017[5] O. Odimabo Onengiyeofori et al. assessed the factors of risk generation by means of sample research and analyzed the factors that have the greatest impact on construction project risks by using RAM to classify the risk factors in the research results, and the final study showed that the main risks affecting construction projects are incorrect construction methods, lack of communication between all parties involved in the project, and failure to fund the project as scheduled[6]. 2021 Senthil J et al. predicted the risks involved in the construction of the project by applying improved historical simulation statistics, for example, climate, inflation, policies, etc. [7].

##### (2) Research on engineering ethics

The concept of engineering ethics began to emerge in American academia in the 1980's. In the 1980's American engineering ethicist M. Davids offered three interpretations of ethics, the first of which he considered ethics to be what we call morality, the second of which he considered ethics to be part of philosophy, and the third of which he considered ethics to be a tool to constrain particular employee behavior. For engineering ethics he explains that this is more towards the second and third of the three interpretations[8]. 2005 Mike W. Martin and R. Schinzinger on two applications of engineering ethics: normative use and descriptive use. In normative use, ethical reference has the value and option of self-protection. "Normative use" has two meanings: first, "ethics" is synonymous with "morality"; second, ethics is a study of morality; it is an ethical inquiry [2].

#### 1.3.2 Current Status of Domestic Research

##### (1) For the study of engineering risk aspects

The concept of "engineering risk" first appeared in the United States, and was later introduced to China by Chinese scholars from foreign countries, and since then, Chinese scholars have started the research related to engineering risk. 2005 Wang Feng By establishing a new risk management procedure to analyze the causes of accidents and combining with the construction example of the Yangtze shield tunnel under the riverbed in Wuhan, the accident tree hazard analysis method was applied to study the safety accidents of water seepage in the Yangtze shield tunnel under the riverbed of the Yangtze River. The basic events of high structural importance are analyzed and countermeasures are taken to improve the safety of project construction. [9]. 2013 Wang Liping The risk of rail transit project in Tianjin was studied to find various causes of risk generation in the process of rail transit construction and to propose certain risk management for engineering risks[10]. 2019 Xinglong Mu A study was conducted on the risks of offshore wind power projects, and after the study, six categories of risks were finally derived, which are: policy risk, design risk, economic risk, construction safety risk, operation and maintenance management risk, and natural risk. Within the six categories of risks, nineteen additional risk factors were identified. [11]. 2022 Jiang Yutao The construction phase risks of the Tangshan LETTE Center project were studied, and it was found that the project not only has conventional management risks, economic risks, and environmental risks, but also has technical risks [12].

##### (2) For research on ethical aspects of engineering

Jiang Hua did a survey on ethical problems in engineering utilization in 2009, and he believed that there are many reasons for ethical problems in engineering utilization, including the appeal of political demands ignoring ethical principles, the game of commercial interests ignoring moral dignity, and the choice of ethical codes due to the differences in cultural traditions [13]. 2015 Zhu Zhou. Research on the ethical responsibility of modern engineering subjects, mainly analyzing the ethical responsibility of government, enterprises and engineers [14]. 2021 Wang Hao Based on the concept of green development, the research on engineering ethics was carried out by using literature research method and case analysis method. Some engineering ethics cases showed that under the constraint of moral framework based on engineering ethics, there are still some engineering constructions at the present stage that affect the maintenance of human social style, neglect the sustainability of ecological protection, and develop economy at the cost of human health [15].

## **2. Related Theories**

### **2.1 The Concept and Meaning of Engineering Risk**

A risk is something that may happen in the future and may cause you damage. Engineering projects have a large investment and a long time, with a high technical content, and there are many uncertainties in the process of construction, and the construction subject will inevitably face many risks. In a broad sense, engineering risks are events that have an impact on the project objectives (cost (capital), schedule (duration), quality, safety) during the project implementation. In order to control project risks, it is necessary to have a clear understanding of the causes and consequences of project risks. Project risks are caused by specific sources of risk or events. The "source of risk" is the factor that causes the risk and the factors that give rise to it. A risk event is an event that affects the accomplishment of project objectives due to the interaction between one or more risk factors. Based on this, an uncertainty-based risk management method is proposed. In the construction process of large and medium-sized engineering projects, for the owner, a large number of risk events during the construction process can often cause significant, even devastating, consequences, thus affecting the achievement of the project objectives.

### **2.2 The Concept of Ethical Responsibility and its Meaning**

Ethical responsibility is taking responsibility and accomplishing things within the limits of what is ethically permissible, and taking moral responsibility for the consequences that may exist. Ethical obligation refers to the obligation that a person or a group of people should have, whether this obligation is good or bad for themselves or for others. In modern society, what people call ethical obligations are closely related to the handling of ethical issues. The core of ethical responsibility is the tendency of human beings to take responsibility for what they do now and for what they will do in the future, which is a forward-looking responsibility, also known as "preventive responsibility." Preventive responsibility is about preventing bad outcomes from happening, or minimizing them. This type of responsibility can be achieved through the cooperation of many parties involved in the act, by anticipating and evaluating the responsible parties, and by making ethical considerations and value judgments in anticipation of certain adverse outcomes in the future. In addition, there is a need to take responsibility for what was done or done, to question the ethics before and after the event, and to take responsibility for the whole event in the long term.

## **3. Causes of Engineering Risks**

First of all, risk itself is uncertain, and engineering risk arises from all aspects of the engineering construction process. Engineering risks are mainly caused by the following five major factors: natural, social, political, economic and legal factors.

### **3.1 Engineering Risks Due to Natural Factors**

Location. In foreign countries, in order to complete a project, trees are often cut down, silt is cleared, roads are built, bridges are built, and even piers are built first. Therefore, before deciding to do a

project, site inspection must be conducted, and if it is a road project, the site inspection must be along the whole route of the road, and only by conducting sufficient inspection can we try to avoid the possible risks.

Climatic conditions. There are also significant differences in climatic conditions between countries. For example, in Russia and Mongolia, the winter is so cold that it is difficult for six months out of the year. And some countries in the Middle East have to put ice inside the cement to cool down in summer because it is too hot; Congo-Brazzaville is located in the tropical rainforest zone of Central Africa, where it rains for 2/3 of the year; and in the Bahamas, a Latin American island country, windproof measures must be taken for construction, etc. So, different weather conditions have different requirements for our response.

Geological risk. Geological hazard is a kind of disaster that needs to be paid attention to. Some projects are soft foundations based on clayey mud, which will lead to the overall sinking of the project if not treated in time; some projects have great difficulties in drainage and foundation treatment due to the existence of karst caves or large cracks, and the karst caves or large cracks are close to the sea; in some projects, the underground rock grade exceeds 6, and such projects generally do not take the excavation plan, which is time-consuming and labor-intensive. In engineering construction, foundation treatment is a link that has a great impact on the construction period and cost. Many projects have experienced delays and cost overruns, and the reason lies in the failure to fully predict the geological risks.

Water supply power. In domestic projects, water supply and power supply do not need to be considered, but in foreign projects, special attention is needed. The voltage and frequency used in some countries are different from those used in China, so all construction machinery in China should be transformed by voltage and frequency first. In addition, the construction sites in many countries are not connected to the city water supply, or the city water supply is very unstable, and there are often water and power outages. At this point, we need to consider using our own generators to supply power. Water source can be obtained by digging wells, if the water from the dug wells is salt water, you also need to equip water trucks to go to specific places to lift water, which is why water is more expensive than oil in the Middle East.

### **3.2 Engineering Risks Due to Social Factors**

For example, land acquisition, demolition and other projects. Land acquisition is a major project that concerns the vital interests of the general public, and the lack of awareness of the people about the policies related to land acquisition makes the people often confront the government in the process of land acquisition and resist against land acquisition in many ways. In the process of land expropriation, the farmers' greatest concern and interest is the loss of their land. The construction process requires the occupation of a large amount of arable land, which in turn needs to be carefully managed by farmers in order to receive sustainable income. Land expropriation will lead to a decrease in the land area per farmer. Arable land is the most important production factor in the region, and the loss of arable land will have a great impact on the daily lives of the people in the region and on agricultural production. Some data show that for farmers, the impact of land loss is far greater than the loss of their houses. In addition, the quality of the preserved agricultural land may be reduced due to various reasons of engineering. Therefore, if the land is expropriated, it will cause the local residents' land area to shrink and even threaten their livelihood, then they will have a strong resistance and resistance to the expropriation and demolition project, and once these negative emotions accumulate, they may develop into strong resistance behaviors, which in turn will threaten the stability of the society. Thus, the progress of the project will be affected.

### **3.3 Engineering Risks Due to Political Factors**

There are two main types of political risks of the project: one is country risk, which refers to the expropriation or confiscation of the project by the government of the project location for certain political or foreign policy reasons, or the imposition of embargoes, joint boycotts, and suspension of

repayment of the project's products. The second type is the risk of national political, economic, and legal stability, that is, the degree of legal perfection, management level, and frequent changes in sensitive issues related to the project, such as foreign exchange management, legal system, taxation system, labor relations, environmental protection, and resource sovereignty. The political risk of the project covers every link and every stage of the project, from the site selection and construction of the project, all the way to the production and operation of the project, marketing and sales, cash flow, profit recovery, etc.

### **3.4 Engineering Risks Due to Economic Factors**

Economic risks in engineering are mainly related to capital management and cost management two aspects. A high proportion of the cost of Construction Material prices market fluctuations, price increases, the cost will be greatly increased; some enterprises for the capital management is not in place, is not good in the construction process of dynamic management, some funds use is unknown, for the project has brought a huge economic risks.

### **3.5 Engineering Risks Due to Legal Factors**

Legal risks caused by incomplete contract formation. However, legal risks can also arise in the process of contracting because of the contracting power of the contracting parties, the qualifications of the contractor and the design of the contract terms. i. In general, most construction units, except for building construction companies and companies that have been engaged in real estate development for a long time, underestimate certain problems that may arise in the execution of construction projects and cannot be fully informed about these problems. Therefore, during the execution of many construction contracts, some contractors and contractors have a great distrust of them, and the reason for this is that the contract is not clear enough and the content is not complete enough, which has become a common problem in construction contract disputes.

Legal risks arising from unknown project content and changes in quantity. During the construction process, a large number of construction processes often take place, and in the construction of building projects, construction projects often give rise to a large number of disputes and risks. The change of the construction quantity involves the change of the price. Therefore, when executing the construction contract, special attention should be paid to the confirmation of the construction quantity and the risks that may arise from the change of the construction quantity.

Visa in the narrow sense of legal risk refers to a written document with agreed meaning during the construction period by the owner's representative, supervising engineer and construction unit's person in charge, according to the provisions of the contract, on the payment of various costs, extension of time, compensation for losses and other issues. Engineering visa is the most important one among engineering visas. In the execution of construction projects, visas are often varied and should be determined on a case-by-case basis. According to its connection with cost, it is divided into technical and economic visas, some of which have dual nature. Visas can be divided into processing visas and information visas according to what they contain. The economic visas and duration visas involved in the project visas are a matter of concern for both the construction unit and the construction company. The risks involved, too, are great, and some may not be able to get the visa done at all.

Legal risk of engineering quality. For example, due to uneven foundation settlement, settlement exceeds the allowable value, or due to insufficient foundation bearing capacity, resulting in cracks, tilting and collapse of the building; safety risks such as structural damage caused by insufficient bearing capacity and excessive deformation of the structure and components due to design and construction quality problems, and quality safety risks such as personal and fire safety caused by quality problems and hidden dangers in the installation of mechanical and electrical equipment. Second, quality problems, it will have an impact on the use of the product. For example, cracks in the walls, blocked pipes, blocked air leaks, mechanical and electrical systems that do not meet the performance of the design requirements. Third is the quality risk, which will have an impact on the environment and health. For example, the harmful ingredients contained in the building materials



exceed the standard, resulting in an indoor environment that does not meet the specification requirements; adverse consequences of the surrounding environment caused by quality problems, etc. Therefore, contractors should pay special attention to quality control, try to avoid disputes, and identify quality problems through identification.

Legal risks in the project settlement. Its legal risk points include: 1. the determination of the amount and period of advance payment; 2. the connection between the payment date of progress payment and progress and quantity; 3. the relationship between the stopping time of progress payment and progress quantity; 4. the issuance of progress payment and settlement payment; 5. the problem of the ratio between settlement amount and quality assurance amount; 6. the contradiction between project progress payment and project time; 7. the payment of advance payment and progress payment and The relationship between settlement payment; 8, the problems about the pricing basis of project price; 9, the problems about project changes and price; 10, the problems about advance payment, progress payment and legal consequences of failure to pay on time.

#### **4. Ethical Responsibility in the Perspective of Engineering Risks**

Risk itself is uncertain, and in order to avoid the generation of risk in a greater possibility, the efforts of all parties are needed, and all parties need to take the initiative to assume responsibility. I will analyze the following three ethical responsibilities under the vision of engineering risks: professional ethical responsibility, social ethical responsibility, and environmental ethical responsibility.

##### **4.1 Professional Ethical Responsibilities**

The sum of moral code, moral sentiment and moral quality required by workers in all aspects of engineering in their work, it is not only the requirement for the behavior of engineering personnel in engineering activities, but also the moral responsibility and obligation to the society. In engineering projects, the responsibility and professional ethics of the staff directly affect the survival and development of the whole project. If the staff lacks responsibility and professional ethics, then it will cause confusion in project management and unclear responsibility and authority in engineering activities, which will greatly increase the construction cost and cause project failure. Second, engineering project personnel should also assume ethical responsibilities to the people they serve, including obligations to them, autonomous decisions, informed consent, practical competence, cultural competence, conflicts of interest, privacy and confidentiality. Third, employees have ethical obligations to their employees, including: respect for employees, confidentiality of employees, cooperation of employees, consultation of employees, and provision of services.

##### **4.2 Social and Ethical Responsibility**

Workers of all parties should take the interests of the service object as their priority, and in the process of service, they should first meet the needs of the service object and maintain the legal rights of the object, which should not be infringed. Adhere to the priority of professional value over personal value, and when there is a conflict between personal value and professional value, workers of all parties should maintain the beliefs and principles of the profession. While maintaining the authority of professional ethics, it is also necessary to maintain the self-discipline of professional ethical responsibility in order to improve the overall level of professional ethical responsibility.

##### **4.3 Environmental Ethics Responsibility**

The core of environmental ethical responsibility is respect for the natural environment. The natural environment plays a vital role in the survival and development of human beings. The ecological balance, ecological diversity and ecosystem functions of the natural environment are vital to human survival and development. Therefore, human beings must respect the natural environment and protect the integrity and stability of the natural ecosystem in engineering construction to ensure the sustainable development of the natural environment. The realization of environmental ethical responsibility requires the active participation of people from all parties in environmental protection.

In summary, from the perspective of engineering risk to analyze the ethical responsibility of engineering, and the main subjects involved are: the government, the Engineering units, engineers, etc.

## **5. Action Strategies for Ethical Responsibility in Engineering Risks**

### **5.1 Action Strategies for Government Ethical Responsibility in Engineering Risks**

To improve the performance and quality of the project, we need to give full play to the government's function in quality control and more protection of the rights and interests of the parties involved.

First of all, the declaration work of construction projects should be strengthened. Construction projects need to be approved by relevant departments before officially starting construction. After accepting the project, the government quality supervision and management department should supervise and manage the declaration procedure and conduct a strict review of relevant information, and issue quality supervision documents only after confirming that all materials have met the requirements. Second, the supervision and review work before the start of construction is strictly implemented. In the time period before the official construction work of the construction project begins and after the declaration of quality supervision, the participating units need to complete the first quality supervision meeting to discuss the work, while the government's quality supervision and management department, to carry out preliminary quality supervision and inspection of the project, and only after the inspection results meet the required standards, the project is allowed to start. Finally, the supervision of the production and operation process is effectively implemented. In the construction link, the government quality supervision and management related responsible departments should inspect each construction project according to the supervision and management program, and if safety hazards or quality problems are found, they should immediately order the relevant responsible units to rectify and provide more guarantee for the quality of construction projects. Fourth, strengthen the quality supervision of the construction stage. After entering the completion stage, the government quality supervision and management department should not take the quality review of the final link lightly, and must strictly check the acceptance link, and combine the actual supervision and management work, prepare and improve the supervision report, establish the corresponding file, and do a good job of recording and archiving and such work to ensure that the important information related to the construction project is kept intact.

### **5.2 Action Strategies for Ethical Responsibility of Engineering Units in Engineering Risks**

First of all, we should attach great importance to project quality and safety production, by continuously deepening the reform of project quality management system; improving and perfecting scientific and orderly quality management system, and formulating scientific and standard evaluation standards and evaluation mechanism. Strict assessment system, forming a complete management organization structure of "traceable source, traceable destination, traceable supervision, traceable responsibility". In order to achieve zero error to ensure zero defects, and enhance the brand effect and quality effect of construction project quality. Secondly, the engineering unit should build and improve the construction quality inspection system, strictly manage the process, do the quality inspection and record of the concealed works, and inform the construction unit and the construction quality supervision agency before the concealed works are carried out.

### **5.3 Action Strategies for the Ethical Responsibility of Engineers in Engineering Risks**

The ethical responsibility of engineers is an important factor in preventing engineering risks. Since engineers are professionals, they are not only able to understand earlier, more comprehensively and more deeply than the general public the possible benefits of a certain engineering result to human beings, but also understand better than others the fundamentals of a certain engineering field and the potential risks that exist. Therefore, the expertise of engineers and technicians determines that they have an unavoidable ethical responsibility for the prevention and control of project risks. As strong as they are, they have a greater responsibility. Therefore, engineers should consciously think about,

predict and evaluate the negative impacts of the projects they work on, and take the initiative to grasp the direction of research; when the situation allows, engineers should automatically stop the hazardous work. The bearer of engineering responsibility is not limited to engineers; it also includes engineering units with many stakeholders. The engineering community includes: scientists, designers, builders, investors, decision makers, managers, acceptors, and users. Shared ethical responsibility in engineering accidents refers to the responsibility of all parties in the community to jointly uphold ethical principles such as fairness and justice.

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