Research on Ethical Issues and Influencing Factors of Ethical Decision Making in Water Conservancy Project

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Abstract. First of all, this thesis makes an in-depth analysis of the key ethical questions existing in hydraulic engineering. It mainly includes value ethics issues, social ethics issues, environmental ethics issues and responsibility and professional ethics issues. Then, it analyzes the important factors affecting on ethical decision-making from micro, meso and macro levels, and gives the principal component analysis (pca) model. Finally, through empirical analysis, it finds several factors that have a greater impact on decision making. They are respectively personal values, work experience, organizational values, industry development maturity, legal soundness degree and environmental awareness. This can provide some reference for government, enterprises, associations and other departments to make decisions and policies.

Keywords: Water Conservancy Project; Ethical Issues; Influencing Factors of Ethical Decision; Risk

1 Introduction

Engineering ethical decision making refers to the process of analyzing and deducing specific ethical problems in engineering according to corresponding ethical standards and moral norms, drawing different alternatives, and selecting the most suitable one in order to solve the ethical problems faced. It is the primary goal of engineering ethical decision-making to prevent the disaster to the public and society. Water conservancy projects have long cycle, large investment funds, high management and coordination difficulties, and far-reaching social and ecological impacts. Once there is a wrong decision, the lack of ethical dimension consideration will have an incalculable negative impact. Therefore, it has become one of the research hotspots of engineering ethics to analyze the influencing factors of ethical decision making and explore the ways to improve ethical decision making.

2 Core ethical Issues in Water Conservancy Project

2.1 Value Ethics Issues

Water conservancy project is a comprehensive technical activity. It needs to consider hydrology, low quality, load and many other factors. It can regulate the distribution of water resources to meet people's needs for water management, such as storage, flood discharge,

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irrigation, and power generation. It has greatly improved people's quality of life and promoted local economic development.

Different from the general engineering activities, the scale and influence of most water conservancy projects are very large, and the geological conditions, construction and operation environment are complex. It is extremely difficult to accurately assess engineering risks because some risks are not foreseen at the engineering design stage, and some effects only become apparent over time. Some impacts are even difficult to recover once formed. This is the embodiment of the external value conflict of water conservancy projects. The internal value conflict of a water conservancy project is mainly reflected in its target conflict in different benefits. For example, the Three Gorges project has functions such as flood control, power generation, navigation, irrigation, etc. Which function should be satisfied first, what is the order of other goals, and how to maximize the utility by optimizing the scheduling. This is the inherent value conflict problem faced by every water conservancy project.

2.2 Social Ethics Issues

In terms of social ethics, water projects are mainly concerned with the conflict of interests of different stakeholders. This is reflected in two aspects, one is the benefit distribution and risk sharing between different regions, and the other is the resettlement and compensation of immigrants[1].

For public welfare water conservancy projects, the investors are all taxpayers, but the beneficiaries are only part of the group, which produces the problem of investment justice. For the water storage and power generation project, it will result in the inundation of the upstream reservoir area and the regulation of the downstream water volume, which will damage its interests and bear a higher risk. For water diversion projects, water supply in some areas has been guaranteed, while others have paid a higher economic and ecological price. In China, water resources are owned by the state, and governments at all levels plan and allocate them. However, when allocating resources, the water use history, benefit distribution and risk sharing of water sources should be fully considered to avoid injustice due to the needs of political and economic development.

The development of a country must be accompanied by the efforts of everyone. For the indigenous people born and raised here, the migration brought by water conservancy projects involves various problems of economy, culture and personal feelings. Taking the Nujiang hydropower development project as an example, according to the development plan, about 4,000 hm^2 of cultivated land will be submerged in the middle and lower reaches, and nearly 50,000 people will need to migrate. Most migrants belong to the rural population, for whom land is the most basic means of production, so the first thing to be considered in the resettlement is how to solve the agricultural land. At the same time, most of these immigrants are ethnic minorities, with their own unique living habits and working methods, and have a strong belonging complex to the original place of residence.

2.3 Environmental Ethics Issues

With the continuous progress of science and technology, human beings' attitude towards nature has also changed, from the initial awe to believe that "man will conquer heaven". Marx once said, "Don't be too intoxicated with our human victory over nature. For every such victory, nature takes its revenge against us." River ecosystem is an interlocking complex system, which has the characteristics of openness, dynamics, non-equilibrium and nonlinearity [2]. Any small change in the initial state can lead to unpredictable changes in the system, known as the "butterfly effect". In the process of construction and use, water conservancy projects have many impacts on the ecological environment, such as the inundate of farmland, the destruction of animal and plant habitats, the extinction of species, and the change of climate. This requires that water conservancy engineering activities should minimize their interference to the natural environment and give necessary humanistic care while transforming nature.

2.4 Responsibility and Professional Ethics Issues

Another important ethical issue involved in water conservancy projects is responsibility and obligation. Who is responsible for the construction of the project? Who is responsible for the consequences of technology, design flaws, or oversight of the construction process?

From the perspective of practitioners, they take professional pride in the value of water conservancy projects and their contribution to society. So while they enjoy the glory, they also bear certain responsibilities and obligations. Water conservancy projects involve a wide range of disciplines and knowledge, which requires employees to first have a solid basic theoretical knowledge system, courage to explore the spirit of research, and good at combining theory with practice. Second, they can make the right choice when faced with different conflicts, such as the interests of different regions or groups of people, individual or collective interests, human interests and environmental interests. These problems are undoubtedly great challenges for policy makers, engineers and other participants in water conservancy projects, and it is difficult to make the right choice that is satisfactory to most people.

Decision makers and practitioners not only need to have the necessary ethics, but also need to enhance the sense of crisis through examining the risks, enhance the sense of mission by analyzing interest conflicts, and strengthen the sense of responsibility through the clear role positioning.

In recent years, due to the lack of responsibility consciousness and ethics consciousness in engineering construction, it is not uncommon to see the cases of inferior projects. In order to satisfy their own personal interests, these decision-makers do not consider the ethical issues in decision-making, lose their moral bottom line, and distort their values. To obtain economic or political benefits, they lose the principle of science, human nature, justice and ecology, laying hidden dangers for the quality and safety of the project and the interests of the people.

3 The Influencing Factors of Ethical Decision Making in Water Projects

Although the government is the main body of water conservancy project decision-making, other individuals or social groups also play an indispensable role in the decision-making process. The influencing factors of ethical decision of water conservancy project can be discussed from micro, meso and macro levels. The decision model is shown in Fig. 1.

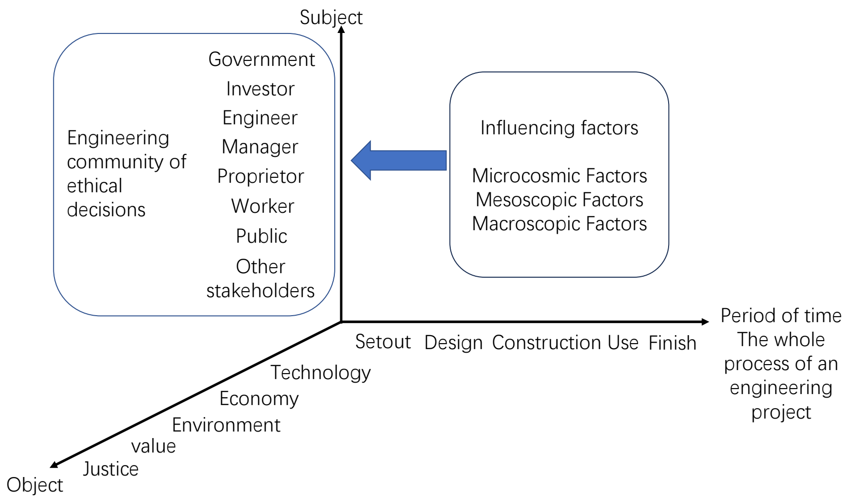

Fig. 1. Ethical decision model diagram

3.1 Microcosmic Factors

At the micro level, the object of study is the individual. What individuals do, can do, and should do in order to grasp and fulfil their ethical responsibilities as employees or employers, colleagues or managers, consumers, suppliers or investors. The factors that affect micro individual ethical decision-making include personal moral level, individual values, education level, work experience, specific as Table 1.

Table 1. Microcosmic Factors

Moral Standards (X_1)	The decision-making subject of engineering ethics will often make the decision scheme that conforms to ethics, when the individual has a high level of moral cognitive development, has correct ethics and follows ethical norms. On the contrary, the engineering decision will appear unethical phenomenon.
Personal Values (X_2)	The influence of personal values on individual decision-making is also huge. Under different value orientations, people adopt different value standards and focus on different goals when making decisions. Fallon(2009) found that there is a positive correlation between the level of moral cognitive development and ethical decision-making when he reviewed the literature[3].
Education Level (X_3)	A large number of statistical results show that there is a positive correlation between ethical decision-making and personal education level. Hawkins & Cocanougher survey found that executives were more perceptive and tolerant of business ethics, through the analysis of 230 students and 83 executives, ethical issues in business were analyzed.
Work Experience (X_4)	Work experience affects decision makers' analytical ability, technical ability and overall cognitive level. It also shows a positive correlation with ethical decision making.

3.2 Mesoscopic Factors

At the meso-level, the object of study is the decision-making and action of economic organizations. Human is the sum of all social relations, and organization is the link to realize the social value of engineering. In the practice of engineering ethics, the role and function of decision-making individuals in engineering activities are often subject to the organizational structure and organizational system. At the organizational level, the factors that affect ethical decision-making include organizational values, organizational ethical norms, and organizational ethical climate [4], specific as Table2.

Table 2. Mesoscopic Factors

Organizational Values (X_5)	In fact, organizational values are the basic beliefs and goals agreed upon by members of the organization. It is also believed and respected by the members of the organization. To realize the organizational values of engineering ethical decision-making, the members of the organization must reach a consensus on the concept of justice and benefit, take integrity as the foundation, and realize the sustainable development of large-scale public projects as the ultimate direction.
Organizational ethical climate (X_6)	The organizational ethical climate is the reflection of the organizational climate of the decision-making subject in the face of ethical decision-making. Different types of organizational ethical climate have different effects on the behavior of its members. For example, compared with the benevolent, principled ethical climate of the organization, it is more likely for the subject to make decisions that are contrary to the requirements of ethics in the organizational ethical atmosphere where self-interest comes first[5].
Ethical Standards (X_7)	Ethical standards and norms of organizations or industries are important influencing factors of engineering ethical decision-making, which can guide and supervise decision-making subjects to make more ethical decision-making schemes. The ethical decision making of the organization develops and enrichis the moral choice of the individual and takes many factors into consideration to achieve the optimal ethical decision making in an appropriate way.
Industry Development Maturity (X_8)	The maturity of industry development is reflected in whether the market mechanism is perfect or not, whether the market players can compete fairly within the system norms, the level of integrity and morality, whether there is an industry association, and whether the industry association can play the necessary role. The high maturity of the industry means sufficient competition and proper supervision, each subject has a high reputation, the whole process of the project can get professional consulting services. And it can help the decision-making subject to make a more ethical decision plan when facing the ethical decision dilemma.

3.3 Macroscopic Factors

At the macro level, the main factors affecting ethical decision-making include Sociocultural factors, regional economic level, public participation and legal soundness, etc., as shown in Table 3.

Table 3. Macroscopic Factors

Regional Economic Level (X_9)	The higher the level of regional economic development, the higher the orientation of the society and the public to the project, and the higher the expectation of the benefits it brings. his also requires that the plan formulated by the decision-making subject is compatible with the level of socio-economic development. Therefore, the technical, safety, economic, environmental protection and other requirements of the program should also match it.
Social culture (X_{10})	Social culture refers to the humanistic quality and ethical level of the whole society, which is positively correlated with ethical decision-making. In an ethical society, the decision-making subject can pay attention to the demands of all stakeholders, maintain the public interest and the ecological balance reduce pollution and maximize the positive effect of the project.
Public Participation Degree (X_{11})	Strictly speaking, the public is the investor and user of water conservancy projects. Public participation enables decision makers to better understand the advantages and disadvantages of water conservancy projects, reduce decision-making risks as much as possible, and avoid mistakes caused by blind and one-sided engineering decision-making. In addition, the public is a supervisor. It is their basic right and duty to exercise the power of supervision and express interest demands.
Legal Soundness Degree (X_{12})	Law is the bottom line of morality. It is a supplement to the moral deficiency to improve laws and regulations. It is a mandatory constraint on individual or collective decision-making behavior. It can ensure that ethical decisions are rule-based, truly implemented and not merely a formality.
Environmental Awareness (X_{13})	Ecological ethics is an important ethical issue involved in decision-making of water conservancy projects. The social awareness of environmental protection greatly influences the technical legitimacy and ecological priorities of the ethical decisions. In terms of multi-objective trade-offs, whether the government can uphold the value concept of ecological priority, pursue harmonious coexistence between man and nature and social sustainable development are positively correlated with the overall environmental awareness of the society.

4 Evaluation of Influencing Factors

Through the identification of micro, meso and macro influencing factors, it can be found that these influencing factors are not completely independent, and there is a certain correlation between some indicators. Therefore, principal component analysis can be used for analysis.

Principal component analysis (PCA) is a multivariate statistical method that converts several index variables reflecting a certain feature of a sample into a few comprehensive variables. The basic idea is to try to replace the original indicators by recombining the original indicators which have a certain correlation into a new set of a few comprehensive indicators which are unrelated to each other. These few composite indicators are called principal components, which are linear combinations of the original variables. This greatly simplifies the repeatability of indicators and makes the evaluation easier to operate. The main analysis process of principal component analysis is as follows.

4.1 Questionnaire Design and Distribution

The design of the questionnaire is mainly divided into two parts. The first part includes the basic information of the respondent, such as gender, age, educational background, nature of work unit and working years. The second part evaluates the impact degree of 13 influencing factors at micro, meso and macro levels, using the 5-branch scale scoring method. 1 indicates no impact, 2 indicates some impact, 3 indicates moderate impact, 4 indicates relatively significant impact, and 5 indicates very significant impact.

The objects of questionnaire survey mainly include government departments, water conservancy design institutes, engineering consulting units, construction units, construction units, environmental protection departments, engineering ethics experts, engineering associations, the public, universities and research institutes, etc. Participants made judgments on the impact of ethical decisions in the scope of influencing factors based on the water conservancy project or work experience they had participated in.

4.2 Data Collection and Collation

First of all, invalid questionnaires should be removed and the distribution of survey objects in various departments should be basically reasonable. Then, the data matrix (n x p) of the statistical sample is extracted. In this model, there are 13 indicators of influencing factors, so p=13, specific as Table 4.

Table 4. Statistical sample data matrix

Index / Sample	X_1	X_2	…	X_{13}
1	x_{11}	x_{12}	…	x_{113}
2	x_{21}	x_{22}	…	x_{213}
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
n	x_{n1}	x_{n2}	…	x_{n13}

4.3 Solving Principal Component

These p indicators reflect the differences between n regions. Through dimensionality reduction, m(m<p) comprehensive indexes are extracted from these p indexes, so that these m comprehensive indexes can basically reflect the regional differences reflected by the original p indexes. If the original indicators are independent of each other, it means that the indicators

cannot be replaced with each other, otherwise the reliability of the research will be affected. However, if p indicators are completely correlated, it is only necessary to use any one indicator to reflect the inter-regional differences.

The new synthetic variable is a linear combination of the original variables, i.e. Eq.(1).

$$\begin{aligned} Y_1 &= u_{11}x_1 + u_{12}x_2 + \cdots + u_{1p}x_p \\ Y_2 &= u_{21}x_1 + u_{22}x_2 + \cdots + u_{2p}x_p \\ &\cdots \\ Y_p &= u_{p1}x_1 + u_{p2}x_2 + \cdots + u_{pp}x_p \end{aligned} \tag{1}$$

In a mathematical transformation, the population variance remains the same and the new synthetic variables remain independent of each other. Among them, Y1 is called the first principal component and is the variable with the largest difference in the new synthetic variable. Y_2 is called the second principal component and is the new synthetic variable with the largest external square difference besides Y_1. By analogy, Y_p is the composite variable with the least variance.

The variance contribution rate of the principal component represents the magnitude of the reaction degree of the principal component to the change of sample information. The greater the variance contribution, the higher the degree of the principal component's characterization of the comprehensive features of the studied region. The variance contribution rate formula of principal component is as Eq.(2).

$$\alpha_k = \lambda_k (\sum_{i=1}^{p} \lambda_i)^{-1} \tag{2}$$

α_k represents the variance contribution rate of the KTH principal component.

The formula for the contribution rate of cumulative variance is as Eq.(3).

$$\sum_{j=1}^{m} \lambda_i (\sum_{i=1}^{p} \lambda_i)^{-1} \tag{3}$$

Generally, if the cumulative contribution rate is greater than or equal to 75%, we can extract the m principal components to represent the original multiple variables for comprehensive evaluation operations. The factor load table and its rotation table can be automatically generated by SPSS, and the weight of each principal component can be calculated by the eigenvalue of the principal component. Finally, the comprehensive evaluation can be made according to the product of the factor score and the principal component weight of each decision-making region. The principal component weight is calculated as Eq.(4).

$$\frac{\lambda_i}{\sum_{k=1}^{p} \lambda_k} \tag{4}$$

4.4 Data Analysis Result

The collected valid questionnaire data were sorted out and input into SPSS software for analysis. The results are as table5.

Table 5. Explanation of the Total Variance

Component	Eigen Roots			Explanation Rate of Variance after Rotation		
	Eigen Roots	Variance Contribution rate (%)	Cumulative Contribution rate (%)	Eigen Roots	Variance Contribution rate (%)	Cumulative Contribution rate (%)
1	3.816	29.353	29.353	2.176	16.735	16.735
2	1.78	13.693	43.046	2.004	15.413	32.148
3	1.335	10.267	53.313	1.687	12.979	45.127
4	1.207	9.288	62.601	1.686	12.969	58.097
5	1.006	7.74	70.34	1.333	10.256	68.353
6	0.789	6.068	76.408	1.047	8.056	76.408
7	0.635	4.887	81.295	-	-	-
8	0.623	4.79	86.085	-	-	-
9	0.478	3.68	89.765	-	-	-
10	0.435	3.345	93.11	-	-	-
11	0.354	2.719	95.829	-	-	-
12	0.309	2.373	98.203	-	-	-
13	0.234	1.797	100	-	-	-

The cumulative variance contribution of the first six components is 76.408%. According to the eigen roots after rotation, the coefficients of each principal component can be obtained, so the comprehensive evaluation model can be written as Eq.(5).

$$T=0.219\ T_1 + 0.202\ T_2 + 0.170\ T_3 + 0.170\ T_4 + 0.134\ T_5 + 0.105\ T_6 \quad (5)$$

Several indicators of ethical decision-making marketing are selected through calculation, as shown in the table6. The results show that the influence of the three dimensions on ethical decision-making is more balanced. In comparison, at the micro level, personal values (X_2) and work experience (X_4) have a greater influence, with weights of 8.84% and 9.32% respectively. At the meso level, organizational values (X_5) and industry development maturity (X_8) have a greater influence, and their weights are respectively 9.01% and 8.21%. At the macro level, legal soundness degree (X_{12}) and environmental awareness (X_{13}) have a greater impact, and their weights are respectively 8.20% and 8.07%.

Table 6. Comprehensive calculation result

Index	weight
Personal Values (X_2)	8.84%
Work Experience (X_4)	9.32%
Organizational Values (X_5)	9.01%

Industry Development Maturity (X_8)	8.21%
Legal Soundness Degree (X_{12})	8.20%
Environmental Awareness (X_{13})	8.07%

5 Conclusion

From the previous literature, scholars mainly focused on the ethical problems existing in water conservancy projects and their causes. Then discussed how to avoid these ethical problems at the level of ethical standards and codes of conduct for practitioners. Although there are also concerns about the influencing factors of ethical decision-making in water conservancy projects, most of them focus on the analysis of the mechanism of these factors on ethical decision-making, and little attention is paid to the degree of influence of each factor in decision-making. Based on this situation, this paper uses the principal component analysis method to try to get the most important factors affecting the ethical decision of hydraulic engineering. Through the attention and improvement of these aspects, the standardization and reliability of ethical decision-making can be improved. On the one hand, resources are always scarce, and each influencing factor will not get enough resources to improve at the same time. Through the extraction of principal components, we can focus on the adjustment and improvement of several factors that have the greatest impact, and the pertinence is stronger. On the other hand, the evaluation can be carried out according to the region. Due to the differences in industry standards, social culture, economic foundation and laws and regulations in different regions, the evaluation results will be different, which can provide reference and reference for cross-regional engineering cooperation and reduce the negative impact of regional conflicts.

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