Artificial Intelligence, Medical Engineering and Education
Z.B. Hu et al. (Eds.)

doi:10.3233/ATDE231344

Intelligent Identification and Analysis of Stakeholders in Waterway Engineering Projects

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Abstract. The waterway engineering project belongs to a government public investment project, with the goal of emphasizing the harmony and unity of the economic benefits, environment, and social aspects of the waterway, and the needs of stakeholders represent the performance of different aspects of the waterway engineering project goals. Focusing solely on the needs of a certain type of stakeholders not only fails to ensure the sustainability of waterway engineering projects, but may also affect the smooth implementation of waterway engineering construction. This article starts from the factors that affect the interests of waterway engineering projects, preliminarily identifies stakeholders, and then identifies and classifies stakeholders in the decision-making stage of the project from the perspectives of initiative, influence, and interest. Core stakeholders, general stakeholders, and marginal stakeholders are identified, providing decision-making reference for waterway construction and governance.

Keywords. Waterway Engineering Project; Stakeholders; Recognition

1. Introduction

The concept of stakeholders originated from the Stanford University Research Institute and is defined as "stakeholders are all individuals and groups who can influence or be influenced by the process of achieving an organization's goals." The results of cooperation, influence, and constraints among stakeholders determine the degree to which an organization's ultimate goals are achieved, which is crucial for project success or improving project performance.

Stakeholders were first proposed by Freeman [1] and divided into one-dimensional categories. Subsequently, Clarkson [2], Wheelers [3], and Mitchell [4] conducted two-dimensional and combinatorial segmentation of stakeholders. In terms of identification, scholars such as Nguyen [5] adopt direct identification of stakeholders, and after providing a definition of stakeholders, they directly obtain the identification object. Scholars such as Newcombe [6], Famiyeh [7], Eskerod [8], and Lv Ping [9] use literature analysis and expert interviews to identify project stakeholders. In terms of analysis methods, scholars have proposed methods such as multidimensional subdivision, social network analysis, and role linkage matrix [10-13]. At present, when scholars use

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multidimensional analysis, there is no clear and unified analytical framework for dimension selection and quantity, and there is relatively little research on stakeholders in waterway engineering projects. Based on this, this article attempts to study the categories of stakeholders in waterway projects from the perspective of stakeholders and the actual situation, clarifying the differences in interest demands of different stakeholders, In order to fully consider the demands of stakeholders at all levels and make targeted decisions in future waterway project planning.

1.1. Concept of Stakeholders in Waterway Engineering

Referring to the concept of stakeholders mentioned earlier, stakeholders in waterway engineering projects refer to individuals or groups who can influence the goals of the waterway engineering project or are affected by the process of achieving the goals of the waterway engineering project.

1.2. Interest demands of stakeholders in waterway engineering projects

Carrying out waterway engineering construction in rivers involves numerous influencing factors. From the perspective of interest impact, the main concerns of stakeholders regarding waterway engineering include:

(1) The improvement effect of waterway engineering construction on waterway conditions, thereby promoting the development benefits of shipping and port industry.

(2) The impact of improving waterway conditions on resource development, industrial development, employment opportunities, and economic income.

(3) The impact of the implementation of waterway engineering on the production activities of residents and fishermen along the river.

(4) The water administration department is concerned about whether the waterway project will affect the connectivity of the river, and whether the construction of the project will have an impact on the flood control of the river.

(5) The environmental protection department is concerned about the impact of waterway engineering on river ecology and aquatic organisms.

(6) As participants in the construction of waterway engineering projects, the design party and construction party are concerned about the commercial benefits and social reputation brought by the engineering construction.

(7) The waterway operation and maintenance department is concerned about maintenance costs and subsequent safety hazards.

2. Stakeholder Analysis Based on System Dynamics

Based on the main concerns of stakeholders regarding waterway engineering, this study mainly adopts the following three steps for stakeholder identification: ① literature analysis: analyze and organize the literature on existing waterway engineering project stakeholders, and preliminarily define the stakeholders of waterway engineering projects; ② Expert judgment: Invite experts in the field of waterway construction to conduct interviews, allowing them to make comprehensive judgments from multiple fields and perspectives, and determine the final stakeholders; ③ System dynamics analysis: From the perspective of waterway engineering project construction, study various stakeholders

as system variables and analyze the main causal relationships between variables; ④ Dimensional analysis, collecting and organizing data, and distinguishing the importance of stakeholders; ⑤ Construction cycle analysis: Conduct separate analysis of stakeholders in different project cycles to clarify their changing trends.

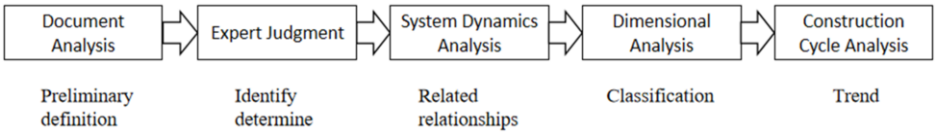


Figure 1. Stakeholder Identification and Analysis Steps

2.1. Identification of Stakeholders in Waterway Engineering Projects

Waterways belong to a type of public goods. The management and construction of waterways are the responsibility of the government.

1. Initial stakeholder list

Based on the analysis of existing literature, stakeholders of waterway engineering project have been preliminarily defined,including: Government (investors), Project Agent Units, Shipping Enterprise, Port Enterprises, Operation and Maintenance Units, The Public, Water Administration Departments, Environmental Protection Departments, Design Parties, Construction Parties, Material and Equipment Suppliers, Supervision Party, Audit Units, Scientific Research Institutions, Insurance Company,
Medium.

2. Finalized stakeholders

In this expert interview, a total of 10 senior experts in the shipping industry were selected, and the interviews were mainly conducted face-to-face and telephone. Through organizing and summarizing the opinions of 10 experts, the following suggestions are obtained: ① The construction of waterway engineering is conducive to the development of ports along the line, and ports and shipping enterprises should be regarded as stakeholders, and shipping enterprises and ports can be merged as end users; ② Both the supervising party and the auditing unit are responsible for controlling and supervising the engineering project, and can be merged as the supervising and auditing party; ③ Insurance companies generally do not participate in waterway engineering construction and do not consider them as stakeholders; ④ Media participation is low and not a stakeholder.

Convene a special group discussion to discuss the list of stakeholders determined after expert interviews. Participants are requested to screen the confirmed stakeholders. Based on the above discussion, a total of 12 types of stakeholders for waterway engineering projects are defined based on the selection percentage exceeding 60%, including Government, Project Agent Units(Agent), End Users(Users), Operation and Maintenance Units(Operation), Social Public(Public), Water Administration Departments(Water), Environmental Protection Departments(Environment), Design Parties(Design), Construction Parties(Construction), Material and Equipment Suppliers(Material), Supervision and Audit Units(Supervision) and Scientific Research Institutions(Research).

2.2. Analysis of Stakeholder Relationships Based on System Dynamics

1. Objectives of the waterway engineering project system

The goal of the system can be expressed as: to coordinate and promote the construction of waterway engineering projects with social, economic development, and environmental protection.

2. Model Assumptions

In order to ensure the integrity of the model and accurately describe the actual causal process, factors with weaker correlation such as population level and consumption level are removed. From the perspective of waterway engineering project construction, the final user, operation and maintenance, social public, environmental protection and water conservancy are studied as variables in the waterway engineering project system.

3. Main causal relationships of waterway engineering project system

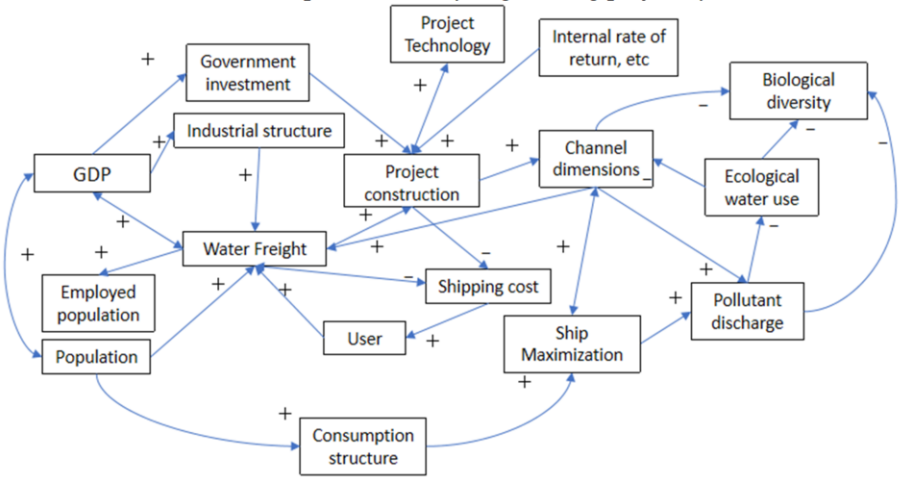


Figure 2. Correlation diagram of waterway engineering project system

The construction of waterway engineering projects has driven the growth of shipping demand in economic and social aspects, such as GDP, population, and water freight volume, which puts forward higher requirements for the construction level and navigation efficiency of the waterway. In terms of environmental protection and water conservancy, increasing the depth of the waterway will to some extent reduce the biodiversity of the aquatic ecosystem. Expanding the width of the waterway and increasing the number of renovation projects will damage the vegetation cover on both sides of the slope protection and the development of natural reserves. Therefore, increasing the scale of the waterway may have negative benefits for the sustainable development of the ecological environment in the watershed. In summary, there are complex relationships among stakeholders in waterway engineering projects. There is both positive and negative feedback, and it is necessary to take the system as a whole and coordinate its development.

3. Empirical Analysis

In recent years, with the construction of the 12.5 meter deep water channel below Nanjing on the Yangtze River trunk line and the formation of the upstream Three Gorges Reservoir area, the conditions of the upstream and downstream channels on the Yangtze River trunk line have been greatly improved. However, the section of the Yangtze River

from Wuhan to Anqing is mostly curved or slightly curved, and the waterway conditions are complex, requiring waterway regulation.

For government investment projects, according to the general project lifecycle classification standards, the entire process of waterway engineering projects can be divided into four stages: project decision-making stage, design stage, project implementation stage, and completion acceptance stage. This article takes the classification of stakeholders in the project decision-making stage as an example, combining three dimensions of initiative, influence, and profitability to classify stakeholders. Finally, a dynamic dimension analysis of the lifecycle is carried out.

3.1. Dimensional analysis of stakeholders

By analyzing the literature and taking into account the characteristics of waterway engineering projects themselves, we can simplify the complexity and grasp the main contradictions, and summarize the analysis perspectives of stakeholders into three main dimensions: initiative, influence, and profitability.

1. Data collection

Considering the characteristics of waterway engineering projects, a survey questionnaire is designed. Based on the 5-level Likert scale, the initiative, influence, and interests of 13 stakeholders in waterway engineering projects are judged, with "1" representing very unimportant, "2" representing relatively unimportant, "3" representing average, "4" representing relatively important, and "5" representing non very important.

The survey questionnaire adopts two forms: paper questionnaire and online questionnaire. A total of 200 questionnaires were distributed, and 174 questionnaires were actually collected, with a recovery rate of 87%. Among them, 101 valid questionnaires were collected, with a response rate of 58.05%. In order to ensure the reliability of the questionnaire data, the Cronbach's Ahpha coefficients were calculated for the 101 questionnaires. The results showed that the coefficients for initiative, influence, and benefit were 0.784, 0.709, and 0.843, respectively, with coefficients greater than 0.7, indicating that the questionnaire data had high reliability.

2. Data analysis method - Mann Whitney U-test

The Mann Whitney U-test can be used to determine whether two populations are the same at the center, that is, to examine whether the median Mx of population X and the median My of population Y are equal. Therefore, the following hypothesis can be proposed:

$$\begin{aligned} H_0 &: M_x = M_y \\ H_1 &: M_x \neq M_y \end{aligned} \tag{1}$$

If H0 is true, mix the data of M x and N y and arrange them together. If most of x is greater than y, or most of y is greater than x, it cannot be proven that n+m=N data come from the same population, and H0 is rejected. The statistical value of the Mann Whitney U-test is U. If the U-value is higher than a certain level of significance (usually set at 0.05), it indicates that there is no difference, and the H0 hypothesis is accepted. Otherwise, it indicates that there is a significant difference, and H0 should be rejected and H1 should be accepted.

3.Data Analysis

The statistical analysis conducted using the Mann Whitney U-test mainly includes: 1) whether there are differences in initiative among stakeholders in waterway

engineering projects; 2) Whether there are differences in influence; 3) Are there any differences in terms of interests.

Firstly, calculate the average initiative of each stakeholder in the construction of waterway engineering projects, and use the Mann Whitney U-test to determine whether there are differences in their contributions. The data analysis results are shown in the table below.

Table 1. Description of the mean of initiative among various stakeholders

Stakeholders	Mean value	Variance	Ranking	Significant differences
Government	4.787	0.685	1	8
Agent	4.632	0.651	2	8
Construction	3.578	1.236	11	3
Design	3.722	1.054	10	3
Material	3.402	1.366	12	2
Public	3.881	1.136	8	6
Supervision	4.472	1.042	5	7
Operation	4.49	1.038	4	6
Research	3.974	1.069	7	7
Environment	3.725	1.163	9	5
Water	4.382	0.946	6	5
Users	4.625	0.681	3	9

From the above table, it can be seen that the stakeholder with the most differences from other stakeholders is the Users, with a total of 9 stakeholders showing significant differences in initiative; The top 3 stakeholders in the average score of initiative, namely Government, Agent, and Users, are more consistent with those who show significant differences. Therefore, it is possible to consider the mean value of each stakeholder and the number of significant differences with other stakeholders.Identify stakeholders as shown in the table above.

By using similar methods for identifying stakeholders in terms of initiative as mentioned above, the stakeholders in terms of influence and profitability can be identified, resulting in the following results.

Table 2 Three dimensional classification results of project stakeholders in the decision-making stage

Dimension	Initiative	Impact	Benefit oriented
Core stakeholders	Government/Agent/ Users	Government/Agent/ Water/Environment	Government/Agent/ Users
General stakeholders	Water/Environment/ Operation/Supervisi on/Research	Supervision/Operation /Users/Design/ Construction/Material	Design/Construction/ Material/Operation/ Research/Supervision
Marginal stakeholders	Designer/Constructi on/Material/Public	Research/Public	Environment/Water/ Public

Based on the classification of stakeholders from three dimensions, the 12 categories of project stakeholders in the decision-making stage of waterway engineering projects can be classified as follows:

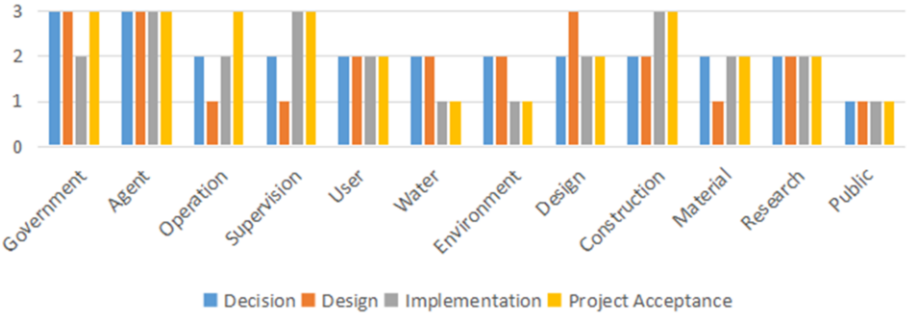
(1) Core stakeholders. At least two dimensions are core stakeholders who are indispensable and closely related to the project process. In the decision-making stage of waterway engineering projects, the core stakeholders are the Government and Agent. The Government is the ultimate decision-maker of the project, providing necessary resources and funds to ensure that the project results meet the needs. Their attitude and behavior are crucial for the impact of the project. Agent also plays an important role in the decision-making stage of waterway engineering projects. In addition, local governments promote the development of water transportation through waterway engineering renovation, thereby promoting the development of local economy.

(2) General stakeholders. At least two dimensions are general stakeholders. They often form a close relationship with the project, and their impact cannot be ignored. In the decision-making stage of waterway engineering projects, there are Operation, Users, Water, Environmental, Design, Construction, Material, Research, Supervision. The water administration department and environmental protection department have administrative approval power and play an important role in project decision-making. As beneficiaries of project results, end users have significant influence on the project and actively participate in the project.

(3) Marginal stakeholders. It scores at least two dimensions among marginal stakeholders, such as Public.

3.2. Stakeholder Changes at Different Stages of the Project Cycle

There are significant differences in the importance of the same stakeholders at different stages of the project construction lifecycle, exhibiting dynamic changes. By using the same method as in the decision-making stage, the classification of stakeholders in the design, implementation, and completion stages can be obtained, as shown in Figure 3.



Note: The vertical axis 1 represents marginal stakeholders, 2 represents general stakeholders, and 3 represents core stakeholders.

Figure 3 Stakeholders at Each Stage of the Project Lifecycle

Stakeholder participation demonstrates the fairness and justice of public products in waterway engineering. Therefore, it is necessary to enhance the ability to scientifically identify stakeholders, strengthen the coordination and management of conflicts among stakeholders, improve the institutional mechanisms for stakeholder participation in decision-making of waterway engineering projects, and enhance the effectiveness of public participation, promoting transparency, legality, and scientificity in decision-making of waterway engineering projects Improvement of effectiveness.

Acknowledgment

This project is supported by Research Projects of China Society of Logistics(2023CSLKT3-310).

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