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The Environmental Influencing Factors of the Realization of Engineering Construction Harmony from the Perspective of Ren–Shi–Wu: Evidence from China

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Abstract: Engineering construction involves many internal factors and external environmental factors, resulting in conflict or uncoordinated problems in engineering management. The harmonious management of engineering construction is the process of coordinating and solving the contradiction between construction elements and the problems between them and the external environment. The connotations of three subsystems of engineering harmony, namely, Ren harmony (RH), Wu harmony (WH), and Shi harmony (SH), are defined, and the system architecture of engineering harmony is constructed. Then, a hypothetical model is proposed to deeply explore the impacts of subsystems such as Ren harmony, Wu harmony, and Shi harmony on engineering harmony, as well as the moderating effects of the natural ecology, social humanities, and political economy on engineering harmony. The results show that (1) natural ecology has a significant promotion effect on RH, SH, and engineering harmony; (2) social humanities have a significant enhancement effect on SH and engineering harmony; and (3) political economy does not play a significant role in any process. "Engineering harmony" is used to measure the effectiveness of engineering management, and a scientific scale is used to reflect this index. It provides a new idea for theoretical exploration and practical guidance in engineering construction management.

Keywords: engineering construction harmony; influencing factors; engineering management; ren harmony (RH); wu harmony (WH); shi harmony (SH); natural ecology; social humanities; political economy

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1. Introduction

Many stakeholders are involved in the project, including owners, design, construction, and supervision, as well as the government and relevant people [1]. Meanwhile, the objectives that need to be controlled in engineering management involve quality, duration, cost, safety, etc. [2,3]. This is a multi-objective optimization and coordination problem [4]. In addition, the project lasts for a long time, and the environment in which the project is located is changeable. It is easy to produce phenomena such as "rent-seeking behavior" [5], "organizational separation", "process separation", and "information island" in engineering construction [6]. Therefore, conflicts and uncoordinated issues are easily caused. Engineering construction is becoming more and more frequent. On the one hand, it plays an important role in politics, the economy, social life, and national defense security. However, on the other hand, a large number of conflicts and contradictions have been caused in engineering, posing a serious crisis to the natural environment and human development.

To solve the conflicts and contradictions in engineering construction and promote the coordinated development of engineering, society, and nature, new engineering construction concepts and engineering construction management methods are needed for guidance.

Harmony is the core concept and essence of traditional Chinese culture. Based on the objectives, key issues, and core tasks of organizational development, the harmony management theory provides a new way to deal with the development of organizations in a complex and changeable environment through a series of tools and methods [7]. Engineering harmony means “engineering should be friendly and coordinated with people and natural environment” [8]. Academician He Jishan pointed out that “the essence of the project is to serve people, but because the major project construction has destroyed the original balance, it is necessary to establish a new balance and new harmony” [9]. Yin Ruiyu, an academician of the Chinese Academy of Engineering, believes that engineering construction has experienced the development process of human beings’ “reverence for nature, conquest of nature, and harmonious coexistence between man and nature” [10]. Wang Qiankun et al. [11] proposed that starting from the coordination of engineering ecology, engineering harmony management refers to the decision-making, planning, organization, and coordination management activities by people to achieve certain human functional goals. It can be seen that engineering construction harmony management is a process in which the stakeholders of the project comprehensively use management means, tools, and methods to coordinate and solve the contradictions between the elements of engineering construction and the problems between the elements and the environment.

In the doctoral thesis, combined with the characteristics and contents of engineering construction, the elements of engineering construction are divided into “Ren” elements, “Wu” elements, and “Shi” elements [12]. This study puts forward that problems abound in the project, such as the balance of construction objectives, the balance of interests of construction organizations, the adaptation of construction technology, and the coordination between the internal elements of the construction and the surrounding environment. Therefore, how to coordinate and solve the contradictions between the subsystems of engineering so that they can develop harmoniously is a problem that needs to be discussed in engineering construction harmony management.

According to the doctoral thesis [12], the contents of engineering construction harmony include (1) “Ren harmony”, which is the coordination of multi-agent interests of “Ren” in engineering organization [1]; (2) “Wu harmony”, which is the multi-constraint objective balance of the project and its “Wu” elements [13]; and (3) “Shi harmony”, which is the matching of “Shi” elements such as engineering construction technology and management methods [14]. Then, on the basis of the three subsystems of RH, WH, and SH, the harmony between the subsystems and the external environmental factors of natural ecology, social humanities, and political economy is realized so as to achieve engineering construction harmony under the joint action of Ren, Shi, and Wu.

In all, the subsystems of “Ren-Shi-Wu” are restricted by the external environmental factors of natural ecology, social humanities, and political economy. The coupling of the three subsystems and the external environments can ultimately achieve engineering harmony. Engineering construction harmony strives to realize the RH, WH, and SH, as well as their harmony with external environmental factors, thus promoting the realization of the comprehensive benefit goal of the project. The realization degree of engineering construction harmony can be evaluated by the “harmony degree” [7,15]. However, “harmony degree” is a relatively vague concept. The concepts of RH, WH, and SH in engineering harmony are also relatively abstract. How the three subsystems of RH, WH, and SH affect the realization of engineering harmony objectives, and how the external environmental factors such as natural ecology, social humanities, and political economy affect and adjust the influence mechanism of RH, WH, and SH on engineering harmony need to be further explored.

2. Literature Review and Concept Connotation

2.1. Literature Review

The impacts of the three subsystems of RH, WH, and SH on engineering harmony, as well as the moderating effects of external environmental factors such as natural ecology, social humanities, and political economy on engineering harmony, were explored in this study. Therefore, a literature review was conducted from two aspects: engineering construction harmony and its influencing factors, as well as the relationship between natural ecology, social humanities, political economy, and engineering construction harmony.

2.1.1. Engineering Construction Harmony and Its Influencing Factors

The concept of engineering construction harmony was clearly proposed in the doctoral thesis, and a relatively systematic and in-depth study was conducted on the management mechanism of engineering construction harmony [12]. Furthermore, the multi-agent interest coordination of engineering construction in the dimension of RH, the multi-constraint objective balance of engineering construction in the dimension of WH, as well as the multi-corresponding relationship adaptation of engineering construction in the dimension of SH were further explored. It is found that the conditional variables in the dimensions of Ren, Shi, and Wu all play important roles, and they are not isolated from each other.

Engineering harmony has a traditional Chinese connotation. Therefore, in the database of Web of Science Core Collection, documents on the topic of engineering harmony and related keywords, such as project success, project performance, and project satisfaction, were collected. In terms of influencing factors, many scholars have studied the key influencing factors of whether the project can achieve harmony [16–19], discussed the interaction between these key factors and engineering harmony, and analyzed the causes of engineering disharmony [3,20,21]. It mainly includes the following aspects.

First of all, the influences of project managers, organizations, and contractors on engineering construction harmony are included in the literature, such as the influence of project managers' personal leadership [17,18] and construction management experience [22] on engineering harmony [23], the influence of managers' moral quality on the construction project performance [24], as well as the effects of engineering organizational culture [25], team diversity [26], team knowledge sharing [27], cooperation and integration degree [28], and maturity of engineering design [29] on engineering harmony. The relationship between the management of contractors and subcontractors and engineering harmony [30,31] includes the impact of a long-term stable relationship [32] or distrust between contractors and subcontractors on the construction project performance [33].

Secondly, as the main objectives of engineering management are quality, duration, cost, and risk, a lot of the literature mainly focuses on the relationship between factors such as quality, duration, cost, safety, and risk and the realization of engineering harmony [2,6,34]. Wang Qiankun used the meta-analysis method to conduct further research on 29 original studies and found that quality, duration, cost, and risk have positive impacts on the realization of engineering harmony [13]. Wyke and Lindhard (2023) used the principal component analysis method to identify potential factors that affect the cost and duration overruns of public construction projects [35]. Yang and Yu used survey data and a structural equation model to evaluate the relationship between project planning, knowledge integration, and engineering harmony [36].

Finally, information and communication technology promotes engineering harmony [37]. For example, digital construction can effectively improve project performance [38]. Machine learning is applied to construction contract management [39]. BIM has brought great advantages to project delivery and performance [40]. The combination of BIM technology and workflow is conducive to the coordination among project participants [41].

2.1.2. Relationship between External Environmental Factors and Engineering Construction Harmony

Combined with the regulating factors of engineering construction harmony discussed in this paper, the research status of external environmental factors such as natural ecology, social humanities, and political economy related to harmonious engineering construction is summarized.

(1) Natural ecology and engineering construction harmony.

Rendle et al. [42] put forward the project site selection steps to reduce the project cost and failure risk according to the environmental and physical conditions. Through the environmental management analysis of hydropower projects, Zhang et al. [43] found that public participation and environmental protection resource investment are the key to the success of the project. Narita et al. [44] studied the robustness of project performance under the high uncertainty of climate change.

(2) Social humanities and engineering construction harmony.

Cultural differences may lead to widespread conflicts between international joint ventures in terms of technology and norms. The technical, cultural, and political relations among international contracting organizations are complex, and cultivating innovative culture is the key factor in improving organizational competitiveness [45]. Liu et al. [46] discussed the influence of national cultural differences on the project performance of joint ventures. Nguyen et al. [47] analyzed the impact of project organizational culture on construction project performance through empirical investigation. Wehi et al. [48] pointed out the importance of incorporating cultural customs into ecological restoration by combining cultural utilization with ecological restoration.

(3) Political economy and engineering construction harmony.

Risk factors can pose a threat to the time, cost, and quality objectives of the project. Some scholars have discussed the impacts of external risk factors on project objectives and engineering harmony [49], including economic, political, and force majeure factors [50]. Kassem et al. [51] used structural equation modeling to explore the impacts of economic, political, and force majeure factors on the success of construction projects and determine internal and external key risk factors [50]. It is conducive to reducing the impact of political risk factors on project success.

2.1.3. Literature Summary

In summary, the issue of harmonious management in the field of engineering construction has been studied from different perspectives, and some valuable results have been achieved. The existing related research mainly focuses on the study of one or several elements, such as the impacts of quality, duration, cost, and risk objectives on the realization of engineering harmony; the impacts of the project manager, project organization, and contractor's behavior on engineering harmony; the impacts of project planning, design, collaboration, and integration on engineering harmony; and the promotion effect of information technology on engineering harmony. The above research provides valuable data and an important reference for this study. However, most of these studies focus on the relationship between factors and engineering harmony, and few studies consider some factors as moderator variables and analyze the moderating effects of these factors on the realization of engineering construction harmony.

In particular, in the doctoral thesis [12], the specific mechanism of realizing engineering construction harmony is studied from three different perspectives: Ren, Shi, and Wu. However, based on the internal perspective of the engineering system and the configuration perspective between Ren, Shi, and Wu, the dynamic influence of external factors in engineering construction is not considered, and the research on the influence mechanism of RH, SH, WH, and external environmental factors (natural ecology, social humanities, and political economy) is not mentioned in the doctoral thesis. This provides an opportunity for this paper.

2.2. Concept Connotation

2.2.1. Engineering Construction Harmony

Engineering construction harmony embodies the core concept and essence of traditional Chinese culture, and it is a process of coordinating and solving many contradictions among the elements of Ren, Shi, and Wu and between them and the environment. "Ren" is the subject of engineering construction, which is the integration of various stakeholders, teams, and individuals, including owners, supervisors, builders and designers. "Wu" is the object of engineering construction, and it is the integration of the objects of material resource elements. "Shi" is the technical relationship between "Ren" and "Wu", including engineering technology, management methods, and construction schemes [12]. The subsystems of "Ren-Shi-Wu" are restricted by the external environmental factors of natural ecology, social humanities, and political economy. The coupling of the three subsystems and the external environments can ultimately achieve engineering harmony.

The concept of engineering construction harmony was clearly proposed in the doctoral thesis [12]. The problems to be solved to realize engineering construction harmony include the following: first, the harmony of "Ren" in engineering construction organization, "Ren harmony (RH)"; second, the harmony of "Wu" in engineering construction projects, "Wu harmony (WH)"; third, the harmony of "Shi" that Ren acts on Wu, "Shi harmony (SH)"; and fourth, the harmony between each subsystem and external environmental factors, which include natural ecology, social humanities, and the political economy. Based on the above analysis, the logical architecture of engineering construction harmony is shown in Figure 1.

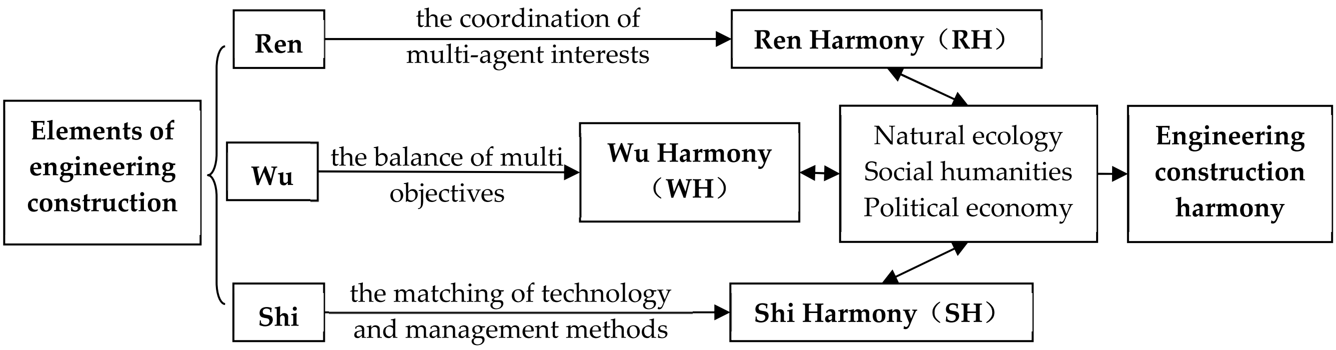

Figure 1. Logical structure of engineering construction harmony.

2.2.2. Ren Harmony, Wu Harmony, and Shi Harmony

(1) Ren Harmony (RH)

"Ren" is the most dominant factor in engineering construction harmony, with multi-dimensional attributes such as "economic man", "social man", and "complex man" [1]. The ideology, values, professional ethics, work attitude, and interpersonal skills of "Ren" collectively determine the connotation and extension of "Ren harmony". RH refers to the consistency of action rules and guidelines exhibited by engineering organizations, teams, and individuals in the process of realizing their respective interests. It is committed to achieving the synergy of engineering construction organizations but does not require complete consistency in the behavioral norms and guidelines of "Ren". Multiple agents and interests are allowed to exist, and the harmonious state of engineering organization goals can be achieved.

(2) Wu Harmony (WH)

"Wu" is an important material guarantee for engineering construction, which involves generalized "Wu" elements such as machinery, equipment, materials, funds, quality, duration, and cost objectives [13]. WH means that the material elements can always be rationally allocated and effectively utilized. Even under the conditions of emergency, difficulty, and danger, it can still meet the material element demands of engineering construction. WH is the functional goal of engineering construction harmony and the state achieved by "making the best use of everything". Material elements can effectively ensure the completion of engineering objectives, and resources can be rationally allocated and effectively utilized.

(3) Shi Harmony (SH)

"Shi" refers to the relationship that "Ren" has with "Wu". It is the necessary method and tool for engineering construction. It includes construction technology, management means, and information methods needed to realize engineering value, construction goals, and tasks [14]. SH is a means of engineering construction harmony. It refers to the harmony of various engineering technologies and management means in engineering construction. It is the state of "getting twice the result with half the effort" in engineering construction. SH is based on technology and method innovation.

2.2.3. Natural Ecology, Social Humanities, and Political Economy

The external environment brings both opportunities and threats to the survival and development of organizations. Drawing lessons from the classification of the environment in management, the engineering construction environment can be divided into a general environment and a specific environment [52]. The moderating effect of the general environment on engineering harmony is discussed in this paper, including natural ecology, social humanities, and political economy. In the natural ecology, social humanities, and political economy environments in which the project is located, tangible or intangible constraints are formed on the engineering construction of the project. This poses a challenge to the realization of engineering harmony.

(1) Natural Ecology

Natural ecology includes topography, geomorphology, geology, climate, hydrology, and so on. The harsh natural ecological environment will significantly increase the difficulty of project construction and management and increase the project cost. The natural ecology should be fully considered in engineering management. A complete construction scheme should be made according to the complex construction environment and conditions.

(2) Social Humanities

Social humanities refer to the traditional social concepts and humanistic qualities of the country or region where the organization is located, such as customs, cultural traditions, values, and religious beliefs. Engineering is endowed with many humanistic connotations. For example, whether humanistic factors are integrated into the design, whether there is humanistic care in construction management, and whether the engineering products reflect customs, cultural traditions, brand culture, team culture, and spiritual culture belong to humanistic connotations.

(3) Political Economy

Political economy refers to the overall political stability of the country where an organization is located. It is the specific attitude of the government toward the development of the organization. It also refers to the socio-economic and national economic policies that constitute the survival and development of enterprises, including the political system, government policies, legal system, international relations, fiscal policies, tax policies, bank interest rates, exchange rates, price levels, disposable income status of residents, and supply and demand of labor force.

3. Basic Assumptions and Conceptual Model

3.1. The Moderating Effect of Natural Ecology

Natural ecology is closely related to the process and results of engineering construction. According to the community theory [53], on the one hand, natural ecology is the basic condition for human survival. The elements, functions, and structures of natural ecosystems all affect engineering construction. Once the natural ecology is out of balance, the bad natural ecological conditions will hinder the project's progress, increase the project cost, and destroy the engineering harmony. On the other hand, engineering construction has an impact on the natural ecology. The concept of engineering ecological development with man and nature as the core should be embodied in engineering construction. For example, a team with outstanding professional skills can design and construct under the premise of protecting the natural ecology so as to reduce the damage of the project to the ecological environment. Engineering participants should respect and protect natural ecology in engineering construction and promote the formation of a new pattern of harmonious coexistence between man and nature. To sum up, this study believes that to maintain the harmonious development of engineering, the engineering team should adhere to the coordination between the organization and the natural ecology. Moreover, the natural ecological balance positively regulates the promotion effect of RH on engineering harmony. Based on this, the following assumption is made.

H1a. *Natural ecology positively regulates the promotion effect of RH on engineering construction harmony.*

A natural ecological environment can strengthen the relationship between WH and engineering harmony. Starting from the engineering system theory [54], engineering construction harmony pursues the establishment of the best relationship between many elements inside and outside the organization. It emphasizes maximizing the positive role of the various system elements and reducing the negative impact. Therefore, the coordination of the internal and external structure of the engineering construction organization and construction relationship is realized, and the optimization of quality, duration, and cost is realized. In engineering construction, excessive demand for natural ecology, excessive emphasis on current benefits, and neglect of the harmonious unity between engineering construction and natural ecology will cause problems such as excessive resource consumption and environmental pollution. This will be detrimental to engineering construction harmony. The constraints of natural ecology require that the complex construction environment and conditions should be taken into account to better control the project quality, cost, and duration. It can be seen that good natural ecological conditions are important conditions for high engineering quality, feasible costs, and reasonable construction periods. Ultimately, the maximization of engineering benefits and management efficiency is achieved. Therefore, the following assumption is proposed.

H2a. *Natural ecology has a positive moderating effect on WH and engineering construction harmony.*

The harmony of natural ecology emphasizes the harmonious coexistence between man and nature and maintains the engineering harmony of natural ecology. It requires full respect for the right to survival and development of nature. Engineering design and construction should be carried out in accordance with the objective laws of natural ecology. According to the theories of ecological carrying capacity and sustainable development [55], under a certain condition, a certain individual has the highest limit number. The resources available for the project in nature are limited. The destruction of the natural environment will definitely threaten engineering harmony. The sustainability of resources and ecosystems is the primary condition for maintaining the sustainable development of human society. In engineering management, to maintain the harmony and stability of the natural ecology, the construction party must avoid the use of technologies, methods, and means that cause excessive damage to the environment or serious overdraft of natural resources. The engineering construction behavior exceeding the ecological carrying capacity will certainly destroy the environment, affect the sustainability of the project, and cause irreversible consequences. In summary, this study believes that to maintain the harmonious development of the project, the technologies, methods, and means that respect the natural ecology should be adopted by the construction party. The stability and sustainability of the natural ecology will positively regulate the promotion effect of SH on engineering harmony. Based on this, the following assumption is made.

H3a. *Natural ecology positively regulates the promotion effect of SH on engineering construction harmony.*

3.2. The Moderating Effect of Social Humanities

According to the social contract theory [56], industry norms and engineering values are reflected in contract justice and engineering personnel ethics. Contract justice is premised on the professional integrity and ethical morality of engineering personnel. Engineering personnel must possess sufficient professional integrity and ethical morality. They jointly promote engineering construction from the perspective of concepts, ethics, systems, and other aspects. By changing the traditional concept of engineering construction and integrating local culture with engineering, the cultural value of the project has been realized, thus achieving the balance of economic value, social value, and ecological value. Without a sound management mechanism, such as a safety system and construction standards, it is easy to cause engineering accidents. Meanwhile, if the engineering personnel lose the professional ethics, internal corruption and sabotage are prone to occur. It will directly affect the quality of the project and is not conducive to the realization of engineering harmony. A good social and humanistic environment promotes the improvement of the contract spirit of engineering personnel and enhances the cohesion of the engineering construction team. Therefore, the following assumption is made.

H1b. *Social humanities positively regulate the promotion effect of RH on engineering construction harmony.*

With the improvement of people's humanistic quality, engineering projects are endowed with more and more social and humanistic connotations. Whether the region, religion, culture, art, etc., are taken into account in the engineering design and whether there is humanistic care in the construction management are all social and cultural environmental factors that need to be considered. Meanwhile, higher requirements are being put forward for the quality of building materials, environmental protection, and energy saving. Under the constraint of social and humanistic environment, on the one hand, the project chooses low-carbon, environmentally friendly, green, and energy-saving materials to promote engineering harmony in engineering ethics. On the other hand, the humanistic connotation of engineering is inseparable from the designer's inspiration and team culture. Engineering can accumulate, inherit, and innovate more classic cultural connotations and details. On the contrary, if people ignore the constraints of the social and humanistic environment, energy conservation, and environmental protection and neglect customs, cultural traditions, and religious beliefs, it can easily lead to problems such as non-compliance with environmental protection requirements and unsold engineering products, making it difficult to achieve the benefits of all aspects of the project. Therefore, this study proposes the following hypothesis.

H2b. *Social humanities have a positive moderating effect on WH and engineering construction harmony.*

A good social and humanistic environment is very important for engineering management. The social and humanistic environment in different regions is very different. Fully respecting local customs, lifestyles, and religious beliefs will provide a strong boost to engineering construction. According to the stakeholder theory [57], stakeholders refer to groups or individuals that affect the production and operation of an organization. The realization of engineering value and the generation of resource value depend on stakeholders. Correctly handling the relationship between enterprises and stakeholders will help to achieve organizational goals and improve enterprise performance. Engineering construction is based on the market environment, and the process of engineering construction is the process of interaction among stakeholders. Engineering construction should pay attention to communication with stakeholders. It should adopt appropriate construction techniques, methods, and strategies without harming the interests of stakeholders so as to carry out engineering construction more efficiently. In a good social and humanistic environment, all stakeholders can maintain a harmonious relationship and engineering construction faces fewer obstacles. Therefore, the following assumption is made.

H3b. *Social humanities positively regulate the promotion effect of SH on engineering construction harmony.*

3.3. The Moderating Effect of Political Economy

According to the theory of coordinated development [58], when a country's economic development undergoes transformation and upgrading, the formulation and continuous updating of political and economic systems, as well as the coordinated development of systems across regions and departments, jointly promote engineering harmony. With the adjustment of national and local legal situations and the upgrading of economic policies, the demand for engineering projects has been constantly adjusted, and the quality and acceptance standards of engineering projects have been continuously improved. If the engineering construction team actively grasps the direction and trend of political and economic changes and actively adapts to the political and economic environment, it can reduce engineering risks and promote engineering construction harmony. Investors should accurately grasp the complexity of stakeholders and the dynamic nature of the economic environment, coordinate the development situation of engineering and macro-economy, and promote engineering construction harmony. The following assumption is made.

H1c. *Political economy positively regulates the promotion effect of RH on engineering construction harmony.*

The introduction of political and economic policies plays a leading and binding role in engineering construction. All projects must be carried out within the scope of policy permission, legal legality, and institutional compliance. The laws, systems, and norms of engineering construction put forward requirements for engineering machinery, equipment, and materials, as well as engineering quality, safety, and risk. With the continuous improvement and standardization of policies and systems, project management has become more scientific, refined, and systematic, and the efficiency of resource allocation and utilization has become higher and higher. The political and economic environment has improved the difficulty and complexity of engineering management to a certain extent. However, from the perspective of sustainable development, it is conducive to standardizing engineering construction behavior and promoting the improvement of project quality. Therefore, the following assumption is put forward.

H2c. *Political economy has a positive moderating effect on WH and engineering construction harmony.*

Engineering construction is influenced by various factors such as national economic policies, political stability, and financial environment. According to the dynamic capability theory [59], to seize business opportunities, organizations need to have a strong speed of technological innovation so as to adapt to the needs of economic globalization, market integration, and customer diversification [60]. Organizations need to have the ability to make quick decisions based on external market changes, thereby significantly enhancing competitive advantage. Political risks mainly stem from the stability of laws and policies in the location of the project, the efficiency of government work, and the business environment. Economic risks mainly stem from the economic strength and development trend of the project location, including a sound and perfect market and the norms of contract behavior. If an organization gradually improves its technology and methods, it will significantly enhance its dynamic adaptability. It is beneficial for the organization to cope with the complex and ever-changing political and economic environment of the market. In a favorable political and economic environment, enterprises face lower political and economic risks and can enjoy the incentives and dividends of economic development, which is conducive to engineering harmony. Based on this, this article proposes the following hypothesis.

H3c. *Political economy positively regulates the promotion effect of SH on engineering construction harmony.*

3.4. Conceptual Model

Engineering construction has experienced the development process of human beings' "reverence for nature, conquest of nature, and harmonious coexistence between man and nature". Engineering harmony means "engineering should be friendly and coordinated with people and natural environment". In other words, engineering construction should respect and recognize the objective laws of nature. Engineering construction should reduce the impact on natural resources and the environment while considering the economic and social impact.

The specific mechanism of realizing engineering construction harmony is studied from three different perspectives of Ren, Shi, and Wu in the doctoral thesis [12]. However, in the doctoral thesis, the dynamic influence of external factors in engineering construction is not considered, and the research on the influence mechanism of RH, SH, WH, and external environmental factors (natural ecology, social humanities, and political economy) is not mentioned.

The three subsystems of RH, WH, and SH affect the realization of engineering harmony objectives. The external environmental factors, such as natural ecology, social humanities, and political economy, affect and adjust the influence mechanism of RH, WH, and SH on engineering harmony. Based on the above conceptual connotation and basic assumptions, the conceptual model is constructed as shown in Figure 2.

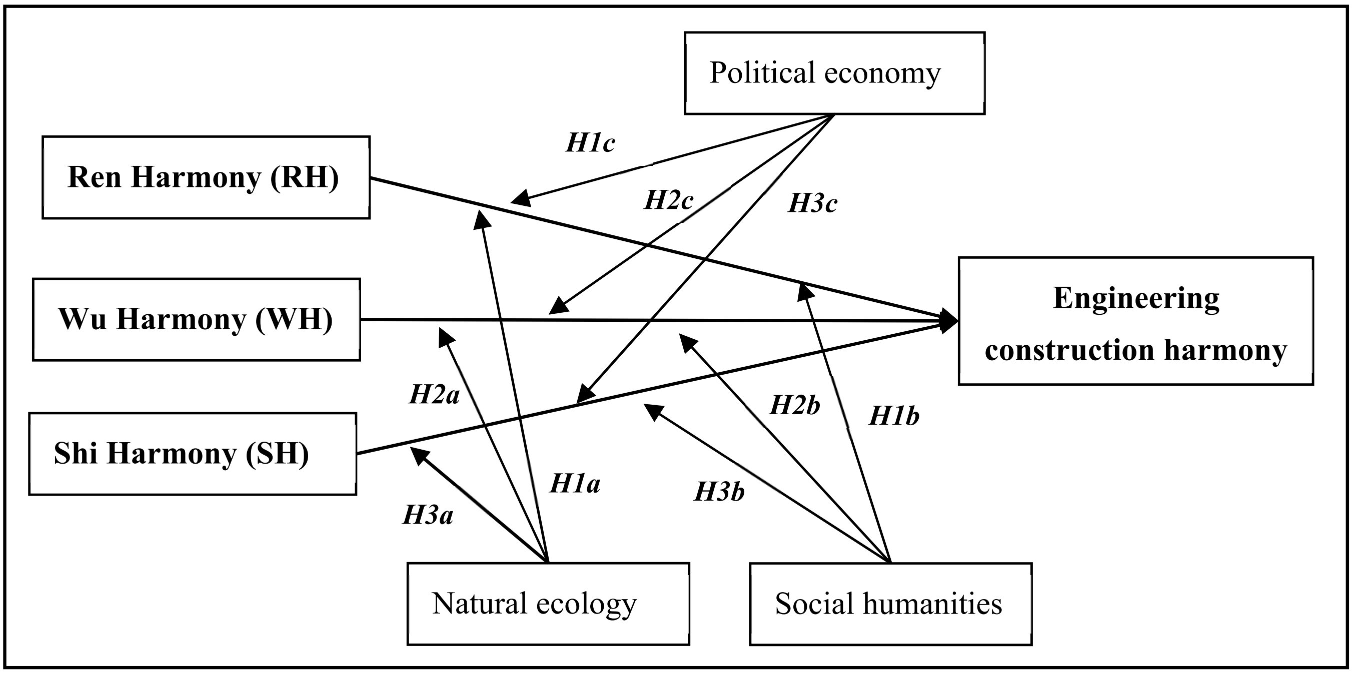

Figure 2. Conceptual model.

4. Methodology

4.1. Technical Route

The technical route of this paper mainly includes five parts, as shown in Figure 3.

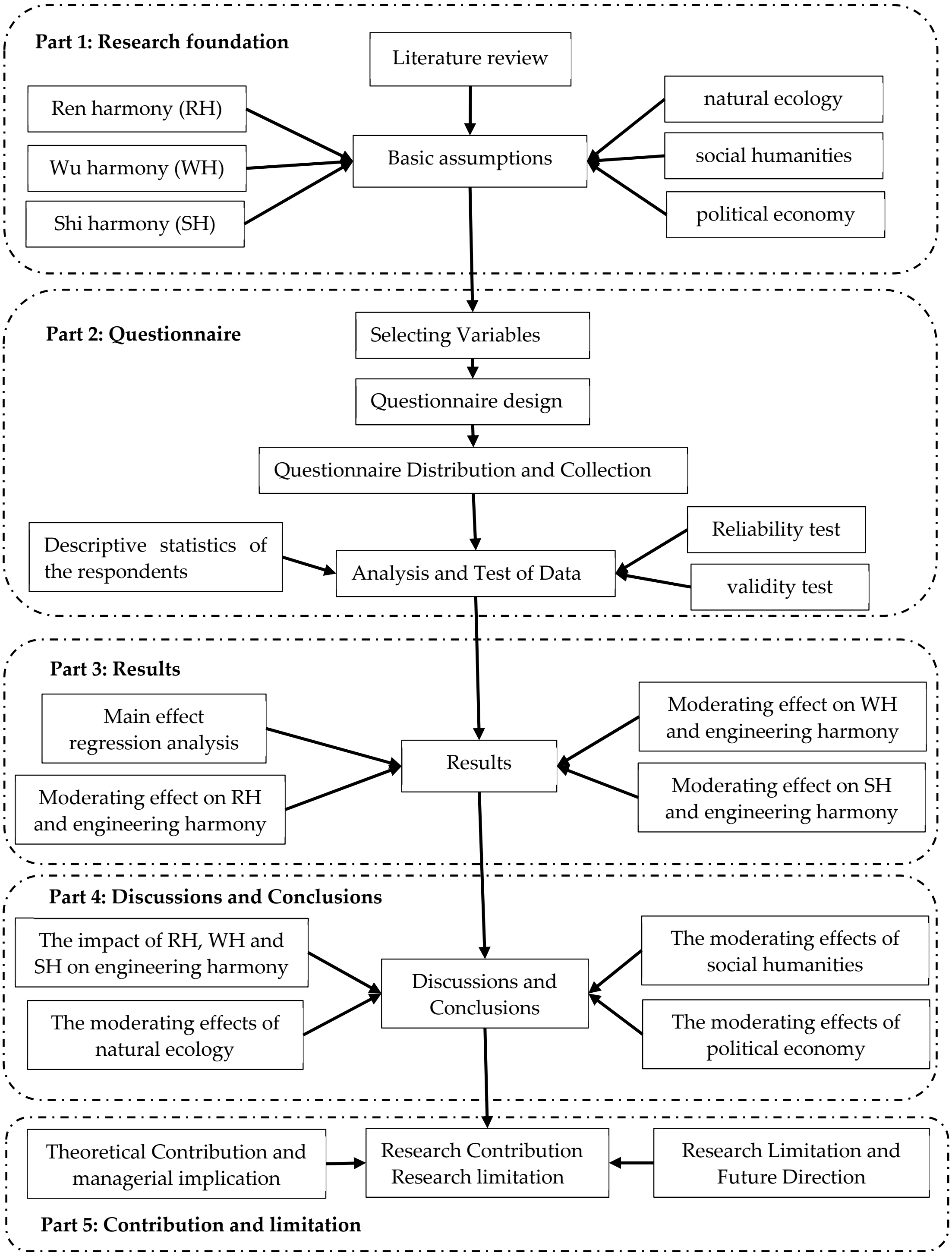

Figure 3. Technical route.

4.2. Questionnaire Survey

A questionnaire survey is a method to collect data by designing detailed questionnaires and asking respondents to answer accordingly. In this paper, questionnaires are designed and recovered to collect the data for analysis.

4.2.1. Selecting Variables

Engineering construction harmony embodies the core concept and essence of traditional Chinese culture. It is a process of coordinating and solving many contradictions among the elements of Ren, Shi, and Wu and between them and the environment. The content of engineering construction harmony includes (1) "Ren harmony", which is the coordination of multi-agent interests of "Ren" in engineering organization; (2) "Wu harmony", which is the multi-constraint objective balance of the project and its "Wu" elements; and (3) "Shi harmony", which is the matching of "Shi" elements such as engineering construction technology and management methods. Then, on the basis of the three subsystems of RH, WH, and SH, the harmony between the subsystems and the external environmental factors of natural ecology, social humanities, and political economy is realized so as to achieve engineering construction harmony under the joint action of Ren, Shi, and Wu.

This study aims to explore the impacts of the three subsystems of RH, WH, and SH on engineering harmony, as well as the moderating effects of external environmental factors such as natural ecology, social humanities, and political economy on engineering harmony. Based on the above analysis, engineering construction harmony is considered the outcome variable. The three subsystems of RH, WH, and SH on engineering harmony are selected as antecedent variables. Natural ecology, social humanities, and political economy are selected as moderator variables.

4.2.2. Questionnaire Design

On the basis of extensive review of previous literature, the measurement of variables is based on the revision of the maturity scale of domestic and foreign scholars. The Likert 5-level scale is adopted in this study, where "1" means that you strongly disagree, "2" means that you relatively disagree, "3" means that you generally agree, "4" means that you relatively agree, and "5" means that you strongly agree [61]. Variables and a total of 31 items were designed, as shown in Table 1.

Table 1. Questionnaire items.

Variables	Number	Items	References
Control variable	1	Your gender	
	2	Your age bracket	
	3	Your educational background	
	4	What is the nature of your work unit?	
	5	How many years have you worked in the engineering industry?	
Ren harmony	6	You are clear about your role in the organization and your work tasks.	Jia Fuwei, (2018) [62]; Tan Lingling, (2019 [63]
	7	You can better complete the tasks assigned by the organization.	
	8	You agree with the team's work objectives.	
	9	You think the team can respond quickly to unexpected events and make the right decision.	
Wu harmony	10	You think that the number of production tools (hardware, software, etc.) needed in the construction process can be met.	
	11	You think that the quality (specification, grade, etc.) of the production tools in the construction process can meet the needs of construction.	
	12	You think that the construction technology and management method of this project are more advanced in the construction process.	
	13	There is no waste of resources in your team.	
Shi harmony	14	Your team can well decompose the overall project objectives into a number of reasonable phased objectives (including quality, duration and cost objectives).	
	15	Your team can well complete the phased objectives (including quality, duration and cost objectives).	
	16	There is no major safety accident in your project.	
	17	Your team has a detailed risk response strategy.	

Table 1. *Cont.*

Variables	Number	Items	References
Natural ecology	18	Your project has no impact on the surrounding natural environment and social production.	She Jianjun, (2007) [64]
	19	The construction of your project will not affect the normal life of the surrounding residents.	
	20	Your project used green energy or materials in the construction process.	
Social humanities	21	The historical inheritance of your project is high.	
	22	Your project has a high degree of integration with urban culture.	
	23	Your project can enhance the brand image of the city.	
Political economy	24	The rise of local material level has not had a substantial impact on the project construction.	
	25	Changes in exchange rates and tax rates have not had a substantial impact on the project construction.	
	26	The policies of local government have a promotion effect on the smooth construction of your project.	
	27	Changes in relevant government quality standards and specifications have not affected the project construction.	
Engineering construction harmony	28	The overall benefit of your project is high.	Shan Yinghua, (2015) [65]
	29	Your project has a high degree of synergy in the construction process.	
	30	The resource allocation of your project is timely and reasonable.	
	31	Different units in your project have a high degree of technical cooperation.	

4.2.3. Questionnaire Distribution and Collection

According to questionnaire design above, the preliminary questionnaire was distributed to two construction units for trial filling and revised accordingly. A formal questionnaire was then created and distributed. The questionnaire star platform was used to obtain the raw data (https://www.wjx.cn/vm/PS1a5US.aspx (accessed on 26 August 2022)), as shown in the part of Supplementary Materials. English questionnaire can be found in Appendix A.

Engineering construction harmony management is a process in which the stakeholders of the project comprehensively use management means, tools, and methods to coordinate and solve the contradictions between the elements of engineering construction and the problems between the elements and the environment. So, the survey participants need to have certain experience in engineering construction. The questionnaire was distributed through e-mails, the online questionnaire platform, WeChat (version 8.0.8), and so on. There are three main methods: (1) The contact information of corresponding authors published in CNKI, WANFANG, CQVIP, and other core journals with research related to the subject was collected. The corresponding industry practitioners and researchers were then invited to fill out a mail questionnaire. (2) The contact information of practitioners and researchers is obtained by participating in relevant conferences and forums in the construction industry. (3) Questionnaire invitations were issued to the professional practice teachers and previous graduates engaged in the industry.

Data collection was conducted from 11 August 2022 to 25 August 2022, and a total of 294 questionnaires were collected. The questionnaire data were screened by the missing value test and abnormal value test, and questionnaires with less than 40 s answer times were excluded. Finally, 268 complete and valid responses were retained. The effective recovery rate of the questionnaire was 91%.

4.3. Statistical Package for the Social Sciences (SPSS)

In this study, Statistical Package for the Social Sciences (SPSS26.0) hierarchical regression analysis is used to test the moderating effects of natural ecology, social humanities, and political economy on RH and engineering harmony, and the operation is carried out according to the test steps summarized by Wen Zhonglin et al. (2005) [66].

5. Results

5.1. Descriptive Statistics of the Respondents

First, a descriptive analysis of the overall situation of the survey participants was conducted. Among the respondents, 221 men account for 82.5%, and 47 women account for 17.5%, with a ratio of 4.7: 1. In terms of age, 136 people aged 25–35 years old account for about half of the total number of respondents. In addition, in terms of academic qualifications, 80 people with a bachelor's degree account for 29.9%; 168 people with a bachelor's degree account for 62.7%, reaching more than half. In terms of the nature of the unit, the construction unit has 218 people, accounting for 81.3% of the total number of respondents. In terms of years of employment, there are 93 people with more than 10 years, accounting for 34.7% of the total number of respondents, as shown in Table 2. The results are shown graphically in Figures 4–7.

Table 2. Descriptive statistics of the respondents.

Items	Category	Number of Respondents (N = 268)	Percentage (%)
Gender	men	221	82.5
	women	47	17.5
Age	under 25 years old	59	22.0
	25–35 years old	136	50.8
	35–45 years old	43	16.0
	45–55 years old	23	8.6
	over 55 years old	7	2.6
Education background	below bachelor's degree	80	29.9
	bachelor's degree	168	62.7
	master's degree (including students)	18	6.7
	doctoral degree (including students)	2	0.7
Nature of work unit	owner	45	16.8
	construction	218	81.3
	consultation	1	0.4
	other units	4	1.5
Years of employment	under 2 years	67	25.0
	2~5 years	52	19.4
	5~10 years	56	20.9
	over 10 years	93	34.7

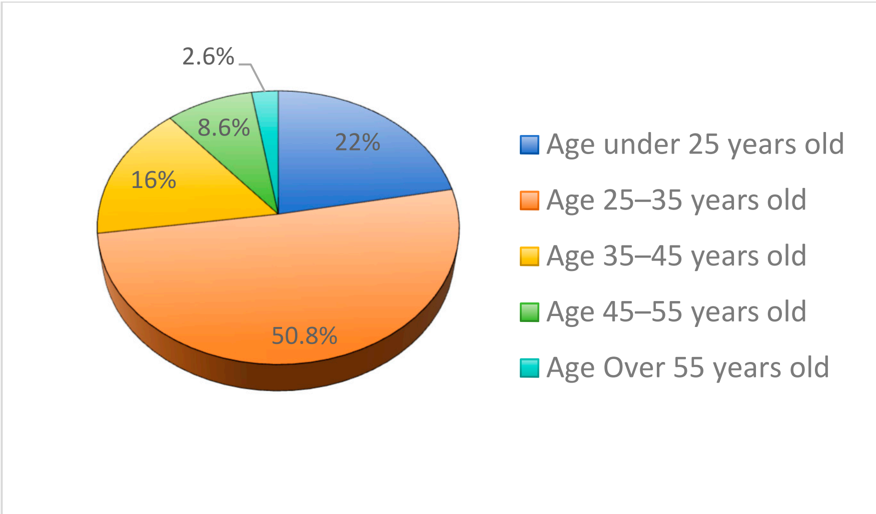

Figure 4. Respondent's age and percentage.

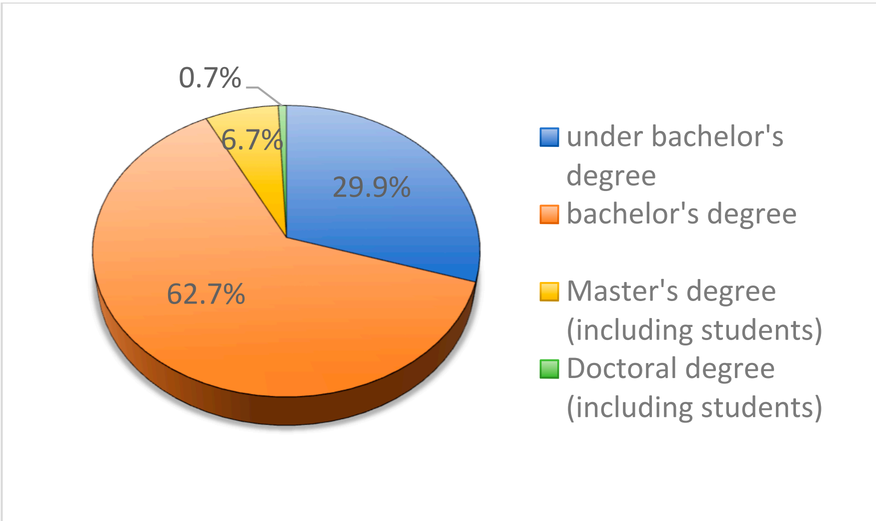

Figure 5. Respondent's education background and percentage.

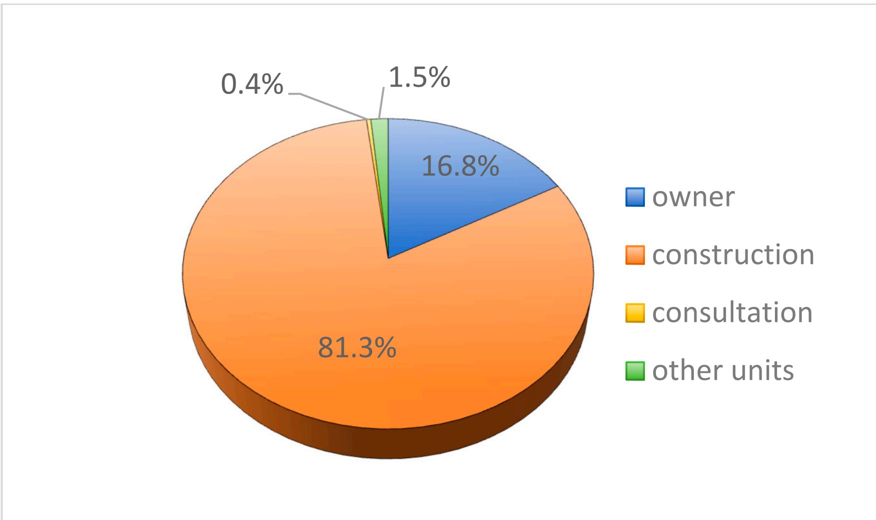

Figure 6. Respondent's unit and percentage.

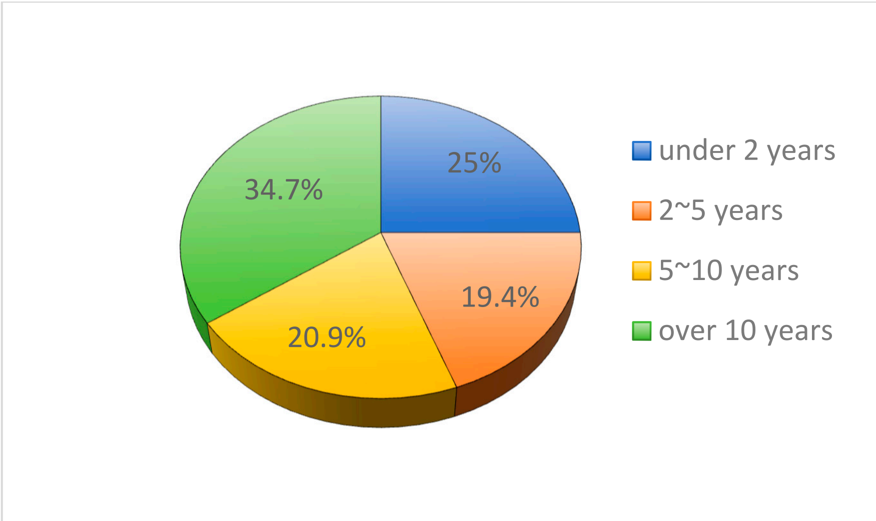

Figure 7. Respondent's years of employment and percentage.

5.2. Reliability and Validity Tests

The reliability test is carried out to ensure its reliability and stability. Judging from the test time and content of the subjects, reliability can be divided into internal trust and external trust. Internal trust refers to a set of problems to measure the same variable, that is, the consistency within the problem and the stability of this variable. The most common test method is Cronbach's α coefficient. External trust refers to the consistency of the test results of the same subject in different periods. In this paper, the variables are tested on the basis of alpha proposed by Cronbach in 1951, and the formula is as follows.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} s_i^2}{s_T^2}\right) \quad (1)$$

where k is the total number of questionnaire questions, s_i^2 is the variance of the score of the i-th question, and s_T^2 is the variance of the total score. The Cronbach's α coefficient is the most commonly used reliability coefficient at present. In general, 0.65~0.70 is the minimum acceptable value, 0.70~0.80 indicates quite good, and 0.80~0.90 is very good. In this study, the questionnaire data were analyzed and processed by SPSS26.0 software, and the results shown in Table 3 were obtained. The values of alpha for RH, WH, SH, natural ecology, social humanities, and political economy are 0.911, 0.934, 0.924, 0.904, 0.904, and 0.917, respectively. The overall Cronbach's alpha is 0.984 and 0.943. Among them, Cronbach's values of the latent variables are all greater than 0.7, indicating that the reliability of the sample data is strong. Thus, the internal consistency coefficient of the calculation scale of all variables essentially meets the requirements, and the observable variables of each sample are relatively reliable.

Table 3. Reliability test.

Variables	Cronbach's Alpha	Number of Items
Ren Harmony (RH)	0.911	4
Wu Harmony (WH)	0.934	4
Shi Harmony (SH)	0.924	4
Natural ecology	0.904	3
Social humanities	0.904	3
Political economy	0.917	4

Secondly, the validity analysis is carried out. The *KMO* test tests the relative size of the simple correlation coefficient and the partial correlation coefficient between the original variables. The formula is as follows.

$$KMO = \frac{\sum\sum_{i \neq j} r_{ij}^2}{\sum\sum_{i \neq j} r_{ij}^2 + \sum\sum_{i \neq j} r_{ij \cdot 1,2 \ldots k}^2} \quad (2)$$

For the *KMO* metric, 0.9 or more is very suitable, 0.8 indicates suitable, 0.7 means general, 0.6 is not suitable, and 0.5 or less is extremely unsuitable. When the sum of squares of simple correlation coefficients among all variables is far greater than that of partial correlation coefficients, the *KMO* value is close to 1. The closer the *KMO* value is to 1, the stronger the correlation between variables. When all *KMO* values are close to 0, it means that the correlation between variables is weaker. The *KMO* value of this study is 0.964, indicating that the questionnaire structure is reasonable.

Finally, descriptive statistics and correlation tests are conducted on the control variables, independent variables, moderator variables, and dependent variables, and the results are shown in Table 4. According to the correlation, it can be seen that RH is significantly positively correlated with engineering harmony ($r = 0.732$, $p < 0.01$). WH is significantly positively correlated with engineering harmony ($r = 0.869$, $p < 0.01$). SH is significantly positively correlated with engineering harmony ($r = 0.823$, $p < 0.01$). They provide a basis for further verification of the research hypothesis.

Table 4. Correlation analysis.

	Average Value	Standard Deviation	Gender	Age	Education	Unit	Working Years	RH	WH	SH	Social Humanities	Natural Ecology	Political Economy	Engineering Construction Harmony
Gender	0.82	0.381	1											
Age	2.19	0.962	−0.082	1										
Education	1.78	0.592	−0.069	−0.112	1									
Unit	1.88	0.478	−0.078	0.1	0.157 **	1								
Working years	2.65	1.194	−0.044	0.693 **	−0.096	0.122 *	1							
RH	4.077	0.902	0.012	−0.064	−0.088	−0.049	−0.056	1						
WH	3.782	0.997	0	−0.145 *	−0.039	−0.084	−0.160 **	0.826 **	1					
SH	3.965	0.961	−0.003	−0.104	−0.028	−0.053	−0.135 *	0.851 **	0.911 **	1				
Social humanities	3.842	1.007	−0.001	−0.113	0.024	−0.08	−0.133 *	0.811 **	0.844 **	0.877 **	1			
Natural ecology	3.828	1.007	−0.02	−0.105	0.011	−0.101	−0.141 *	0.802 **	0.818 **	0.829 **	0.876 **	1		
Political economy	3.703	1.011	−0.019	−0.154 *	−0.011	−0.08	−0.200 **	0.746 **	0.850 **	0.823 **	0.829 **	0.861 **	1	
Engineering construction harmony	3.655	1.08	0.004	−0.167 **	0.002	−0.112	−0.178 **	0.732 **	0.869 **	0.823 **	0.850 **	0.828 **	0.900 **	1

Note: * means $p < 0.05$; ** means $p < 0.01$.

5.3. Result Analysis

In this study, the hierarchical regression method is used to test the hypothesis, and the test results are shown in Table 5. M1 in the table is the analysis result of introducing control variables into the regression model. M2 is obtained by adding the explanatory variable RH on the basis of M1. The results show that RH is significantly positively correlated with engineering harmony (β = 0.726, $p < 0.001$). It means RH can promote engineering harmony management, so the hypothesis of H1 is supported. Similarly, M3 is obtained by adding the explanatory variable WH on the basis of M1. The results show that WH has a significant positive correlation with engineering harmony (β = 0.861, $p < 0.001$). It means WH can promote the development of engineering harmony, so H2 is supported. M4 is obtained by adding the explanatory variable SH on the basis of M1. The regression results show that SH is significantly positively correlated with engineering harmony (β = 0.812, $p < 0.001$). It means SH can promote the development of engineering harmony, so H3 is supported.

Table 5. Main effect regression analysis.

Variable	Engineering Construction Harmony			
	M1	**M2**	**M3**	**M4**
Gender	−0.015	−0.013	0.001	−0.003
Age	−0.083	−0.042	−0.023	−0.064
Education	−0.005	0.062	0.038	0.026
Work unit	−0.090	−0.071	−0.041	−0.064
Working years	−0.111	−0.095	−0.016	−0.014
RH		0.726 ***		
WH			0.861 ***	
SH				0.812 ***
ΔF	2.391 *	310.667 ***	779.383 ***	541.861 ***
R2	0.044	0.563	0.760	0.689
ΔR2	0.44	0.520	0.716	0.645

Note: * means $p < 0.05$; *** stands for $p < 0.001$.

(1) The moderating effects of natural ecology, social humanities, and political economy on RH and engineering harmony

In this study, SPSS26.0 hierarchical regression analysis is used to test the moderating effects of natural ecology, social humanities, and political economy on RH and engineering harmony, and the operation is carried out according to the test steps summarized by Wen Zhonglin et al. (2005) [66]. Firstly, the analysis of control variables is included to obtain M1. Secondly, the natural ecology and RH are centralized, respectively, and then the interaction term between RH and natural ecology is calculated. M2 represents the relationship between engineering harmony and RH after decentralization. M3 is obtained by adding decentralized natural ecological variables on the basis of M2, and M4 is obtained by adding an interaction term between RH and natural ecology on the basis of M3. M5 is obtained by incorporating decentralized social humanistic variables on the basis of M2, and M6 is obtained by incorporating an interaction term between RH and social humanities on the basis of M5. M7 is obtained by adding decentralized political and economic variables on the basis of M2, and M8 is obtained by adding the interaction term between RH and political economy on the basis of M7.

According to the conclusion obtained by Wen Zhonglin et al. (2005) [66], the significant relationship between interaction items and engineering harmony shows that natural ecology, social humanities, and political economy have moderating effects on RH and engineering harmony. The results are shown in Table 6. M4 in the table shows that the interaction term between RH and natural ecology plays a significant role in engineering harmony (β = 0.097, $p < 0.05$). It means the natural ecology has a moderating effect on RH and engineering harmony, so H1a is supported. M6 in the table shows that the interaction term between RH and social humanities has no effect on engineering harmony (β = 0.081,

$p > 0.05$). It means social humanities do not play a moderating effect on RH and engineering harmony, so H1b has not been verified. As shown in M8 in the table, the interaction term between RH and political economy has no effect on engineering harmony (β = 0.025, $p > 0.05$). It means the political economy does not play a moderating effect on RH and engineering harmony, so H1c has not been verified.

Table 6. Moderating effect on RH and engineering harmony.

Variable	Engineering Construction Harmony							
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Gender	−0.015	−0.013	0.007	0.007	−0.006	−0.007	0.013	0.013
Age	−0.083	−0.042	−0.063	−0.060	−0.048	−0.051	−0.048	−0.048
Education	−0.005	0.062	0.008	0.008	−0.007	−0.006	0.028	0.029
Work unit	−0.090	−0.071	−0.027	−0.019	−0.037	−0.032	−0.044	−0.043
Working years	−0.111	−0.095	−0.027	−0.037	−0.037	−0.042	0.029	0.027
RH		0.726 ***	0.201 **	0.269 ***	0.135 *	0.194 **	0.140 **	0.159 *
Natural ecology			0.654 ***	0.647 ***				
RH * natural ecology				0.097 *				
Social humanities					0.727 ***	0.720 ***		
RH * social humanities						0.081		
Political economy							0.791 ***	0.787 ***
RH * political economy								0.025
ΔF	2.391 *	310.667 ***	127.561 ***	4.841 *	169.111 ***	3.576	380.997 ***	0.557
R2	0.044	0.563	0.7070	0.712	0.735	0.739	0.823	0.823
ΔR2	0.44	0.520	0.144	0.005	0.172	0.004	0.260	0.000

Note: * means $p < 0.05$; ** means $p < 0.01$; *** stands for $p < 0.001$.

(2) The moderating effects of natural ecology, social humanities, and political economy on WH and engineering harmony

In the same way, the moderating effects of natural ecology, social humanities, and political economy on WH and engineering harmony are tested. Firstly, the analysis of control variables is included to obtain M1. Secondly, the natural ecology and WH are centralized, respectively, and then the interaction term between WH and natural ecology is calculated and put into SPSS26.0 for statistical analysis. M2 represents the relationship between engineering harmony and WH after decentralization. M3 is obtained by adding decentralized natural ecological variables on the basis of M2. M4 is obtained by adding an interaction term between WH and natural ecology on the basis of M3. M5 is obtained by incorporating decentralized social humanistic variables on the basis of M2. M6 is obtained by incorporating an interaction term between WH and social humanities on the basis of M5. M7 is obtained by adding decentralized political and economic variables on the basis of M2. M8 is obtained by adding the interaction term between WH and political economy on the basis of M7. The results are shown in Table 7.

Table 7. Moderating effect on WH and engineering harmony.

Variable	Engineering Construction Harmony							
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Gender	−0.015	0.001	0.007	0.006	0.000	−0.001	0.013	0.012
Age	−0.083	−0.023	−0.038	−0.038	−0.032	−0.032	−0.037	−0.037
Education	−0.005	0.038	0.021	0.021	0.013	0.014	0.028	0.029
Work unit	−0.090	−0.041	−0.026	−0.021	−0.033	−0.030	−0.037	−0.037
Working years	−0.111	−0.016	−0.005	−0.005	−0.014	−0.015	0.031	0.031
WH		0.861 ***	0.575 ***	0.585 ***	0.522 ***	0.525 ***	0.372 ***	0.379 ***
Natural ecology			0.351 ***	0.374 ***				
WH * natural ecology				0.062				
Social humanities					0.401 ***	0.417 ***		
WH * social humanities						0.036		
Political economy							0.582 ***	0.583 ***
WH * political economy								0.015
ΔF	2.391 *	779.383 ***	52.106 ***	3.609	60.920 ***	1.258	163.480 ***	0.296
R2	0.044	0.760	0.800	0.803	0.806	0.807	0.853	0.853
ΔR2	0.44	0.716	0.040	0.003	0.046	0.001	0.093	0.000

Note: * means $p < 0.05$; *** stands for $p < 0.001$.

In the table, M4 shows that the interaction term between WH and natural ecology has no effect on engineering harmony ($\beta = 0.062$, $p > 0.05$). It means the natural ecology does not play a moderating effect on WH and engineering harmony, so H2a has not been verified. M6 shows that the interaction term between WH and social humanities has no effect on engineering harmony ($\beta = 0.036$, $p > 0.05$). It means social humanities have no moderating effect on WH and engineering harmony, so H2b has not been verified. M8 shows that the interaction term between WH and political economy has no effect on engineering harmony ($\beta = 0.015$, $p > 0.05$). It means the political economy has no moderating effect on WH and engineering harmony, so H2c has not been verified.

(3) The moderating effects of natural ecology, social humanities, and political economy on SH and engineering harmony

Similarly, according to the previous steps, SPSS26.0 hierarchical regression analysis is used to test the moderating effects of natural ecology, social humanities, and political economy on SH and engineering harmony. Firstly, the analysis of control variables is included to obtain M1. Secondly, the natural ecology and SH are centralized, respectively, and then the interaction term between SH and natural ecology is calculated. M2 represents the relationship between engineering harmony and SH after decentralization. M3 is obtained by adding decentralized natural ecological variables on the basis of M2. M4 is obtained by adding an interaction term between SH and natural ecology on the basis of M3. M5 is obtained by incorporating decentralized social humanistic variables on the basis of M2. M6 is obtained by incorporating an interaction term between SH and social humanities on the basis of M5. M7 is obtained by adding decentralized political and economic variables on the basis of M2. M8 is obtained by adding the interaction term between SH and political economy on the basis of M7. The results are shown in Table 8.

Table 8. Moderating effect on SH and engineering harmony.

Variable	Engineering Construction Harmony							
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**
Gender	−0.015	−0.003	0.007	0.005	−0.003	−0.005	0.013	0.012
Age	−0.083	−0.064	−0.067	−0.064	−0.055	−0.057	−0.053	−0.054
Education	−0.005	0.026	0.008	0.008	−0.003	−0.002	0.022	0.024
Work unit	−0.090	−0.064	−0.036	−0.028	−0.043	−0.037	−0.045	−0.044
Working years	−0.111	−0.014	−0.004	−0.007	−0.018	−0.020	0.038	0.038
SH		0.812 ***	0.438 ***	0.475 ***	0.338 ***	0.368 ***	0.258 ***	0.281 ***
Natural ecology			0.454 ***	0.476 ***				
SH * natural ecology				0.100 **				
Social humanities					0.541 ***	0.557 ***		
SH * social humanities						0.077 *		
Political economy							0.684 ***	0.680 ***
SH * political economy								0.036
ΔF	2.391 *	541.861 ***	66.478 ***	7.209 **	70.577 ***	4.166 *	232.554 ***	1.400
R2	0.044	0.689	0.752	0.759	0.755	0.759	0.836	0.837
ΔR2	0.44	0.645	0.063	0.007	0.066	0.004	0.147	0.001

Note: * means $p < 0.05$; ** means $p < 0.01$; *** stands for $p < 0.001$.

In the table, M4 shows that the interaction term between SH and natural ecology plays a significant role in engineering harmony (β = 0.100, $p < 0.01$). It means the natural ecology has a moderating effect on SH and engineering harmony, so H3a is supported. M6 shows that the interaction term between SH and social humanities plays a significant role in engineering harmony (β = 0.077, $p < 0.05$). It means social humanities have a moderating effect on SH and engineering harmony, so H3b is supported. M8 shows that the interaction term between SH and political economy has no effect on engineering harmony (β = 0.036, $p > 0.05$). It means the political economy does not have a moderating effect on SH and engineering harmony, so H3c has not been verified.

6. Discussions and Conclusions

By constructing a model that RH, WH, and SH affect engineering construction harmony and introducing natural ecology, social humanities, and political economy as moderator variables, the managers and constructors of engineering construction were investigated, and 268 valid questionnaires were collected for empirical analysis. The main conclusions are shown in Table 9.

Table 9. The moderating effects of environmental influencing factors.

Engineering Construction Harmony	Ren Harmony (RH)	Wu Harmony (WH)	Shi Harmony (SH)
Natural ecology	○	×	○
Social humanities	×	×	○
Political economy	×	×	×

Note: ○ means "positively effect"; × means "no moderating effect".

6.1. The Impact of RH, WH, and SH on Engineering Harmony

(1) Ren harmony (RH) has a strong positive impact on engineering harmony.

In the process of engineering construction, it is necessary to put people first, make full use of the elements of "Ren", give full play to the enthusiasm and cooperation spirit of employees, and improve their teamwork ability. It is conducive to the realization of engineering construction harmony. By reasonably optimizing the organizational structure and establishing good employee competition and cooperation relations, the coordination among employees, organizations, and the external environment can be realized [67]. Previous studies have shown that coordination among team members can give full play to the enthusiasm and initiative of engineering participants and reduce conflicts among members in interests, culture, and psychology, thereby reducing the negative impact of subjectivity and uncertainty. Engineering organizations are often composed of people from different regions and cultures. It enhances the complexity of engineering construction harmony [68]. RH can realize the harmony of interpersonal relationships in the organization [69].

(2) Wu harmony (WH) has a significant positive impact on engineering harmony.

WH is the basic basis and functional goal of engineering construction harmony. It is mainly manifested in the perfection and sufficiency of basic production equipment and reasonable resource allocation in engineering construction [70]. WH is the foundation of engineering construction harmony. It aims to achieve engineering quality, duration, and cost objectives. In engineering construction, resource allocation, technological innovation, quality control, and cost control will have a profound impact on engineering [71]. Firstly, perfect equipment helps to improve the speed of engineering construction. Secondly, advanced construction technology and management means can effectively solve the problem of resource imbalance. In addition, a higher level of material security system can effectively promote the coordination of multi-objectives such as engineering quality, duration, and cost, thereby achieving engineering harmony.

(3) Shi harmony (SH) has a significant positive impact on engineering harmony.

SH has a promotion effect on engineering construction harmony, and it is usually achieved through the improvement of construction technology and scientific technological innovation. Construction parties can increase technology research and development and improve the technical level [11]. Strict engineering construction technology and standards have been formulated to make the process more rigorous and avoid unnecessary waste. The selection of different technologies will have different effects, and appropriate technologies can maximize efficiency. Through these technical means and management methods, construction can improve its efficiency, reduce construction costs, and help construction achieve a state of SH as much as possible.

6.2. The Moderating Effects of Natural Ecology

(1) Natural ecology positively regulates the promotion effect of RH on engineering harmony.

The natural ecological environment is the foundation of human production and development. Engineering construction also has a certain impact on the natural ecology. Based on the responsibility for the sustainable development of future generations, it is necessary to fully consider the negative impact of engineering construction on natural ecology and adhere to the concept of engineering ecological development based on the coordinated development of man and nature [11]. An excellent organization team can combine the project with the external environment while protecting the natural environment. Meanwhile, a good natural ecology is embodied in a people-oriented ecological environment. It promotes RH and further promotes the positive role of natural ecology between RH and engineering harmony [13]. Therefore, the hypothesis of H1a is established.

(2) Natural ecology has no moderating effect on the promotion of WH to engineering harmony.

In the process of engineering construction, WH means making the best use of the current resources and exceeding the value for money. The research shows that compared with the positive regulation of natural ecology on RH and engineering harmony, natural ecology has a positive effect on WH and engineering harmony, but it is not significant. Therefore, the hypothesis of H2a has not been verified. In the process of engineering construction, the scheduling problem of resource surplus and resource shortage needs special attention, and material plans and procurement need to be carried out according to resource requirements. Because the material resources are limited, the excessive plunder and consumption of natural resources will lead to the unstable development of engineering harmony and the material plan can be coordinated as a whole according to the existing resources. If the behavior beyond the ecological capacity is taken, it will inevitably destroy the environment and cause irreversible effects, thus leading to disharmony in engineering construction. Through the above means, the WH in engineering construction can be better achieved so that the project party can benefit from a good natural ecological environment.

(3) Natural ecology positively regulates the promotion effect of SH on engineering harmony.

SH is the performance of achieving its work and high working efficiency in engineering construction. Natural ecology is a kind of natural material and energy that can affect human survival and development. In the process of engineering construction, it is necessary to have an innovative attitude toward "Shi". Innovation can better combine all the elements in engineering construction so as to better break and rebuild the ecological environment of engineering construction, maintain the dynamic balance of the engineering construction system, and enhance the promotion effect of natural ecology on SH and engineering harmony. The variability of natural ecology also requires comprehensive consideration of complex and harsh construction environments, needs to use more advanced and practical technologies, and avoids using technologies and methods that cause serious damage to the environment. Through the above methods, the state of SH in the process of engineering construction can be better achieved; that is, H3a is established.

6.3. The Moderating Effects of Social Humanities

(1) Social humanities have no moderating effect on the promotion of RH to engineering harmony.

Engineering is endowed with more and more social and humanistic connotations, and humanistic factors such as region, religion, culture, and art should be considered in engineering design. A good social and humanistic environment can promote effective communication, enhance the contractual spirit of project participants, and improve the cohesion of the team. Humanistic care should be reflected in construction management. Project managers need to have professional ethics and professional integrity. However, in engineering construction, the continuous improvement of material production mode can achieve good economic and social benefits. It can be seen that social humanities have no direct moderating effect on the promotion of RH to engineering harmony; that is, H1b has not been verified.

(2) Social humanities have no moderating effect on the promotion of WH to engineering harmony.

A good social and humanistic environment is an important guarantee for the success of the project. The social and cultural environments in different regions are very different. Full respect and adaptation to customs, lifestyles, and religious beliefs will play a great role in promoting the coordinated development of the project. Excessive exploitation and utilization of resources will lead to the unsustainable development of engineering construction. Social humanities can strengthen the sense of responsibility for the sustainable development of future generations by raising people's awareness of conservation. However, the engineering construction is based on the local market, and the social humanities have been fully considered in the project design and construction. The social humanities have been deeply integrated with engineering construction. This leads to the respondents having limited feelings about the role of social humanities in the promotion of WH to engineering harmony. Therefore, social humanities have no moderating effect on the promotion of WH to engineering harmony; that is, H2b failed to be verified.

(3) Social humanities positively regulate the promotion effect of SH on engineering harmony.

The data results show that social humanities can positively regulate the promotion effect of SH on engineering harmony. The relationship between the subject and the object of the project will change with the different social and humanistic environments in different regions. It makes SH play a greater role in the project in different environments. In engineering construction, it is necessary to minimize the use of technologies and methods that damage the environment. If the engineering construction method that exceeds the ecological load is adopted, it will have a negative impact on the sustainable development of the environment. In addition, SH must maintain innovation. Through technological innovation, the advancement and applicability of technology can be better improved so as to enhance the promotion effect of SH on engineering harmony and further improve the social and humanistic value. To sum up, social humanities positively regulate the promotion effect of SH on engineering harmony; that is, H3b is established.

6.4. The Moderating Effects of Political Economy

(1) Political economy has no moderating effect on the promotion of RH to engineering harmony.

The political and economic environment plays a limited role in the influence of RH on engineering harmony; that is, H1c has not been verified. There may be the following reasons. First of all, although RH plays an important role in promoting engineering harmony, the positive influence is gradually weakened under good political and economic conditions. The more adversity the engineering enterprises face, the more they can show the talents of managers. Secondly, superior economic policies may cause managers to have cognitive biases and make irrational decisions that they fail to realize. In addition, information about the market economy, such as exchange rate and tax rate changes, is not common sense in life. Non-procurement or non-sales personnel pay less attention to such information. It leads to a dull perception of the market economy environment in the research sample [72]. The research results have a certain degree of false. It makes this part of the empirical test unable to fit the research hypothesis well.

(2) Political economy has no moderating effect on the promotion of WH to engineering harmony.

In the process of engineering construction, a positive economic system and clear laws and regulations can theoretically promote the rational allocation of resources and engineering harmony. However, this study finds that this effect is limited; that is, H2c has not been verified. The political and economic environment mainly affects the economic activities of enterprises and external units, such as material procurement and technical cooperation. Engineering construction activities rely more on engineering standards and norms. In this case, the key to achieving engineering harmony lies in the introduction of standards and norms. In addition, the political environment affects the transnational operation of enterprises to a large extent. For domestic engineering construction enterprises, the political and economic environment is relatively stable and has a relatively small impact on engineering construction. In addition, it cannot be ruled out that errors may be caused by the respondents' insufficient perception of the changes in the stable political and economic environment.

(3) Political economy has no moderating effect on the promotion of SH to engineering harmony.

From the research conclusion (3), it can be seen that there is no doubt that SH has promoted engineering harmony. However, the political economy does not have a significant moderating effect on the promotion of SH for engineering harmony; that is, H3c has not been verified. This may be due to the following reasons. First, the existing technologies and methods adapt to the current political and economic environment. Engineering technology innovation needs a lot of investment. The original technology has market advantages, and managers are unwilling to change the existing situation. Therefore, conservative technologies and methods are chosen in innovation reform. It makes the path of dependence of innovation more serious. Second, the improvement of innovation ability comes from the dynamic external environment, and the current good political and economic environment cannot have a significant impact on engineering management. Therefore, there is no theoretical positive impact mechanism of innovation-oriented SH on engineering harmony.

7. Research Contribution and Research Limitations

7.1. Theoretical Contribution and Managerial Implications

(1) It provides a good perspective for the realization of engineering management performance and provides a new idea for the theoretical exploration and the practical guidance of engineering construction management.

In this paper, the concept and content of "engineering construction harmony" are put forward, and the connotation definition and system division of RH, WH, and SH in the performance of engineering construction harmony are carried out. Engineering construction harmony can only be realized when the coordination state is achieved within the subsystems of RH, WH, and SH and between the subsystems and the external environment. Compared with traditional engineering management methods, the concept of "harmony" is used to guide engineering management. Engineering harmony is used to measure the effectiveness of engineering management, and a scientific scale is set up to reflect this index. RH, WH, and SH have obvious multidimensional advantages. This paper provides a new idea for the theoretical exploration of engineering construction management and practical guidance of engineering construction.

(2) It has been proved that Ren harmony (RH), Wu harmony (WH), and Shi harmony (SH) are three indispensable and important factors in realizing engineering construction harmony.

Ren, Shi, and Wu, as the elements that make up engineering, must simultaneously transform into three coordinated states: RH, WH, and SH. Engineering construction harmony must first ensure the harmony of three subsystems: RH, WH, and SH. RH is the leading factor of engineering construction harmony. It realizes the coordination among the organization, employees, and the external environment by rationally optimizing the organizational structure and strengthening the competition and cooperation among employees. WH is realized through resource allocation and engineering target control. It has a far-reaching impact on the completion of engineering and is the functional goal of engineering construction harmony. SH can improve the efficiency of engineering construction through strict engineering standards, strengthening technological innovation, and selecting applicable technologies. It is an important guarantee for engineering construction harmony. Therefore, in the process of engineering management, it is necessary to pursue the development balance of RH, WH, and SH and build a people-oriented, harmonious, and synergistic mechanism for engineering construction.

(3) The mechanism of external conditions such as natural ecology, social humanities, and political economy acting on engineering harmony is explored.

External environments such as natural ecology, social humanities, and political economy have formed tangible or intangible constraints on engineering construction and have also posed new challenges regarding whether engineering can be harmonious and how to realize harmony. It is necessary to explore the mechanism of its impact on engineering harmony from the external environmental factors. It is generally believed that external environmental factors such as natural ecology, social humanities, and political economy can simultaneously have a positive moderating effect on the promotion of RH, WH, and SH to engineering harmony. However, based on the analysis of the questionnaire survey results, this study concludes that the role of the three is limited. Natural ecology has a promotion effect on RH, SH, and engineering harmony. Social humanities only have an enhancement effect on SH and engineering harmony. Political economy does not play a significant role in any process. The reason why the role of political economy is not obvious may be that the domestic political and economic environment is relatively stable, and the respondents' perception of this external environment is low. Generally speaking, engineering harmony is indirectly influenced by external environmental factors. However, because the moderating effects of natural ecology, social humanities, and political economy on RH, WH, and SH are limited, engineering harmony is directly influenced by RH, WH, and SH within the system.

(4) In the process of engineering construction, it is necessary to pay attention to the influence of natural ecology and social humanities on engineering harmony and focus on the changing trend of political economy.

Natural ecology has a promotion effect on RH, SH, and engineering construction harmony. In the process of engineering construction, it is necessary to pay attention to the protection and rational utilization of natural ecology and adhere to the concept of engineering ecological development with the coordinated development of man and nature. First of all, in the planning and design phase, the coordination of engineering with climate, topography, geology, hydrology, and other conditions should be maintained. Secondly, in the process of construction, the construction technology and construction techniques should be reasonably selected to avoid using technologies and methods that cause serious damage to the environment so as to minimize the negative impact of engineering construction on the natural environment. In addition, a good natural ecological environment can better promote people-oriented engineering construction. It can also strengthen engineering technology innovation and technical level improvement, thus improving the efficiency of engineering construction and realizing the common improvement of economic and social benefits.

A good social and humanistic environment can enhance the promotion effect of SH on engineering harmony. In the process of engineering construction, engineering teams should strengthen their learning and understanding of social and corporate culture. It is necessary to strengthen the training of the team's divergent thinking and overall ability, constantly improve and enrich the knowledge structure, improve the technical innovation ability, and enhance the team's adaptability to the new environment. Managers' understanding and recognition of corporate culture are conducive to establishing an interactive management system. It is also convenient to pay attention to the differences of individual members and improve work adaptability and post-responsibility. Thus, employees' enthusiasm and satisfaction are enhanced, and SH can play a greater role in promoting engineering construction harmony.

7.2. Research Limitations and Future Directions

This study explores the impacts of the three subsystems of RH, WH, and SH on engineering harmony, as well as the moderating effects of external environmental factors such as natural ecology, social humanities, and political economy on engineering harmony. But the limitations of the topic are as follows: (1) The sample data are mainly collected in China, and future research should expand the research objects, including foreign practitioners and researchers. (2) The original data came from the questionnaire, which may have subjective bias; thus, future works can try to use practical engineering cases to study environmental influencing factors of the realization of engineering construction harmony.

Supplementary Materials: The following supporting information can be downloaded for the Chinese questionnaire using the following link: https://www.wjx.cn/vm/PS1a5US.aspx (accessed on 26 August 2022); the English questionnaire can be found as part of Appendix A.

Author Contributions: Conceptualization, W.Z. and Q.W.; methodology, W.Z.; software, W.Z.; validation, W.Z. and Q.W.; investigation, W.Z. and N.Y.; resources, W.Z. and Q.W.; data curation, W.Z. and N.Y.; writing—original draft preparation, W.Z. and N.Y.; writing—review and editing, W.Z.; visualization, W.Z. and N.Y.; supervision, Q.W. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Questionnaire on Engineering Construction Harmony

Dear Sir/Madam,

Thank you very much for taking the time to participate in this questionnaire. This questionnaire is only for academic research about the evaluation of engineering construction harmony, and it does not have any commercial use. Please fill in according to your actual situation. We apologize for taking up your valuable time. Thank you for your cooperation!

Part I Basic Information

1	Your gender?				
	○ men	○ women			
2	Your age bracket?				
	○ under 25 years old	○ 25–35 years old	○ 35–45 years old	○ 45–55 years old	○ Over 55 years old
3	Your educational background?				
	○ under bachelor's degree	○ bachelor's degree		○ Master's degree (including students)	○ Doctoral degree (including students)
4	What is the nature of your work unit?				
	○ owner	○ construction	○ consultation	○ other units	
5	How many years have you worked in the engineering industry?				
	○ under 2 years	○ 2~5 years	○ 5~10 years	○ Over 10 years	

Part II The evaluation of engineering construction harmony

The engineering construction harmony management is a process in which the stakeholders of the project comprehensively use management means, tools and methods to coordinate and solve the contradictions between the elements of engineering construction and the problems between the elements and the environment. The Likert 5-level scale is adopted in the study, where "1" means that you strongly disagree, "2" means that you strongly disagree, "3" means that you generally agree, "4" means that you strongly agree, and "5" means that you strongly agree.

		1	2	3	4	5
6	You are clear about your role in the organization and your work tasks.	○	○	○	○	○
7	You can better complete the tasks assigned by the organization.	○	○	○	○	○
8	You agree with the team's work objectives.	○	○	○	○	○
9	You think the team can respond quickly to unexpected events and make the right decision.	○	○	○	○	○
10	You think that the number of production tools (hardware, software, etc.) needed in the construction process can be met.	○	○	○	○	○
11	You think that the quality (specification, grade, etc.) of the production tools in the construction process can meet the needs of construction.	○	○	○	○	○
12	You think that the construction technology and management method of this project are more advanced in the construction process.	○	○	○	○	○
13	There is no waste of resources in your team.	○	○	○	○	○
14	Your team can well decompose the overall project objectives into a number of reasonable phased objectives (including quality, duration and cost objectives).	○	○	○	○	○
15	Your team can well complete the phased objectives (including quality, duration and cost objectives).	○	○	○	○	○

		1	2	3	4	5
16	There is no major safety accident in your project.	○	○	○	○	○
17	Your team has a detailed risk response strategy.	○	○	○	○	○
18	Your project has no impact on the surrounding natural environment and social production.	○	○	○	○	○
19	The construction of your project will not affect the normal life of the surrounding residents.	○	○	○	○	○
20	Your project used green energy or materials in the construction process.	○	○	○	○	○
21	The historical inheritance of your project is high.	○	○	○	○	○
22	Your project has a high degree of integration with urban culture.	○	○	○	○	○
23	Your project can enhance the brand image of the city.	○	○	○	○	○
24	The rise of local material level has not had a substantial impact on the project construction.	○	○	○	○	○
25	Changes in exchange rates and tax rates have not had a substantial impact on the project construction.	○	○	○	○	○
26	The policies of local government have a promotion effect on the smooth construction of your project.	○	○	○	○	○
27	Changes in relevant government quality standards and specifications have not affected the project construction.	○	○	○	○	○
28	The overall benefit of your project is high.	○	○	○	○	○
29	Your project has a high degree of synergy in the construction process.	○	○	○	○	○
30	The resource allocation of your project is timely and reasonable.	○	○	○	○	○
31	Different units in your project have a high degree of technical cooperation.	○	○	○	○	○

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