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Research Article

Rural Infrastructure Lifecycle Inclusiveness Impact Path Analysis: Combining Logical Framework and Structural Equation Modeling

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The rural infrastructures require inclusiveness in the whole lifecycle (WLC) for the benefits of the society. The theory of inclusive growth has been widely studied since its introduction in the infrastructure system research. However, the majority of the related studies has focused on macro level measurements and no systematic research has been carried out on the microlevel for inclusiveness formation and impact path discovery so that detailed recommendations regarding the process can be formulated. The WLC of infrastructure is a dynamic process, reflected in different stages with various activities and multiple factor groups that connect and influence each other. To address and analyze this dynamic and interdependent process from a micro perspective, this study applies the logical framework method in constructing nine impact paths of rural infrastructure inclusiveness for the WLC, which revealed the influence mechanism of rural infrastructure inclusiveness at the microlevel. According to the results, "project quality" has the most significant influence on the rural infrastructure inclusiveness.

1. Introduction

Developing countries face poverty problems, especially in their rural areas [1]. Scholars studying the relationship between economic growth and poverty have found that the former does not necessarily result in poverty reduction [2]. In view of this situation, the World Bank (WB) proposed a new economic growth theory, namely, inclusive growth [3], and listed it as one of the three pillar strategies. The Organization for Economic Cooperation Development (OECD) has also set strategic objectives for rural development, which emphasizes the governance of multisectors, the linkage of urban–rural development and the inclusive growth [4]. The Asian Development Bank (ADB) defines inclusive growth as an ensuring growth that the economic opportunities created by the growth are available to all, particularly the poor, to the maximum possible extent [5]. Since the reform and opening up, China's economy has maintained a high-speed of growth, and the poverty in rural areas has decreased significantly. However, the income gap between urban and rural areas in China has widened with the economic growth which shows that the unbalanced income distribution caused by the development has not been effectively alleviated by the economic growth [6]. Therefore, there is a need for the China's rural areas to adopt inclusive growth.

The positive effect of infrastructure on economic growth has been generally observed by the academic research [7–9]. Rural infrastructure is an important factor in eliminating poverty, promoting economic development, and enhancing fairness [10]. In China, there is a huge difference in infrastructure investment between urban and rural areas. In 2017, China's per capita investment in rural infrastructure was 9,554 yuan, while the per capita urban infrastructure investment was 19,327.6 yuan [11]. The investment in rural infrastructure is insufficient and the quality is not high. It has seriously hindered the inclusive development of rural China. Therefore, the provision and management of rural infrastructure are the direct means to achieve inclusive growth in the rural areas. With the adjustment of macro policies, the development of rural infrastructure construction has also experienced a process of constant adjustment. Although the amount of rural infrastructure is relatively small compared with the total amount of urban infrastructure, the total amount of facilities built and to be built is very huge. In 2017, 809.3 billion yuan was invested in the rural infrastructure [11]. According to the rural revitalization plan, more investment will be made in rural infrastructure in the future, which means that the operation and maintenance of existing infrastructure and the development of new rural infrastructure will inevitably require much attention.

Infrastructure development needs to follow a complete lifecycle approach which includes investment decision-making, construction implementation, operation and maintenance, and numerous other tasks [12, 13]. The increased complexity in the planning arena could potentially be solved by increasing the inclusiveness of infrastructure lifecycles [14].

Numerous studies on inclusive growth have been conducted on the macro level which focus on a whole region or area, but much less studies have been performed on the microlevel which focus on the project or program level and presents a clearer impact path of inclusiveness for the whole lifecycle (WLC) of the rural infrastructure. As such, there exists no clear definition of factors to evaluate the progress of inclusive growth on these different levels [6].

To conclude, inclusiveness for the WLC of rural infrastructure has not been systematically studied in the previous studies on microlevels to understand the impact paths and the factors involved. Therefore, this study aims to conduct an analysis on the influencing factors for rural infrastructure inclusiveness specifically to reduce urban and rural gaps and to understand the impact paths on inclusiveness for better designing and planning of the future rural infrastructure.

The paper is structured as follows: Section 2 presents the detailed literature review, followed by the methodology illustration in Section 3 with the developed hypotheses. Section 4 introduces the data source, questionnaire design, and tests the reliability and validity of the data. Section 5 illustrates the structural equation modeling results using empirical data to validate the impacting path assumptions made in Section 3. The last section concludes the research findings and discusses the future directions.

2. Literature Review

Inclusive growth is a concept in development economics. The concept of inclusive growth has been widely used in policy formulation by major international institutions such as the United Nations (UN), the WB [15], and the ADB [16]. There is no complete agreement on this theory, but it is generally accepted to summarize the existing literature and define it as "inclusive growth, which emphasizes ensuring that the economic opportunities created by growth are available to all-particularly the poor to the maximum possible extent." Its core pillars are built on the four dimensions of economic growth, social equity, environmental sustainability, and infrastructure. At present, relevant researches mainly focus on three aspects: concept definition, implementation path, and relationship measurement.

Inclusive growth is a constantly developing concept, and many authors try to explain inclusive growth according to their own views in different study fields. In terms of business organization, Herrera [17] applied the inclusive theory to a new business development model. In the field of finance, the evolution of inclusive finance based on inclusive growth theory is the main achievement. Specifically in urban planning and construction, inclusive cities have formed a relatively mature research field. Zhang and Wang [18] analyzed the concept of inclusive development which is clearly defined and emphasized in urban planning strategies, and the implementation of inclusive cities is an important way to solve the inequity of income distribution. For the implementation paths, the inclusive cities should be people-oriented, including the rural population during urbanization, so as to achieve fairness in the development process [18]. Yan and Yang [19] discussed the influencing relationship between public investment and inclusive development of urbanization, and believed that to improve inclusiveness, studies should be carried out in terms of increasing investment in environmental protection, improving household registration reform, and establishing a reasonable evaluation system. Chu et al. [20] took a town as a case to discuss the implementation strategies of inclusive towns for farmers. For the relationship measurement aspect, Satterthwaite and Tacoli [21] argued that the contribution of socially inclusive growth depends on the existing social and economic structures in urban and rural environments, the power relations between them, and the development strategies on the national level. Chu et al. [20] discussed the relationship between climate sensitivity and community inclusiveness. Through the study of Saipan and other cases, it was concluded that climate sensitivity was closely linked to community inclusiveness. Poor people are more vulnerable to climate change, and the degree of climate change impact in communities can be reduced by providing them with needed infrastructure. Cinderby [22] investigated the important role of public participation in the inclusive strategy of cities, and proposed a method to better guide public participation through geospatial analysis of public voting routes.

Specifically, scholars believe that rural infrastructure is closely related to inclusive growth. The rural infrastructure are the facilities and services provided in the rural areas for agricultural production and meeting the needs of the rural people [23]. There are many ways to classify rural infrastructure, which can be divided into for-profit and nonprofit types, or be classified according to the use types [24]. The National Development and Reform Commission divides rural infrastructure into four categories in the report of "The Rural Infrastructure Construction and Development Report" published in 2013 [25], and this classification method has also been adopted by many literatures on rural infrastructure research (Table 1).

Despite these classifications, Wang [26] summarizes the relationship between the rural infrastructure construction and inclusive growth, and finds that inclusive growth contributes to the growth of investment in infrastructure, but

Table 1: Rural infrastructure categories.

Categories	No.	Title
Agricultural production infrastructure	1	Circulation market
	2	Water conservancy facilities
	3	Irrigation
Rural development infrastructure	4	Rural drinking water
	5	Rural Electrification
	6	Rural road
	7	Rural biogas
Rural social infrastructure	8	Rural school
	9	Clinic
	10	Communication
	11	Culture and entertainment
	12	Gymnasium
Rural environmental infrastructure	13	Public toilet
	14	Sewage treatment
	15	Refuse transfer station
	16	Refuse landfill

not too much emphasis should be paid on a certain kind of infrastructure investment, otherwise it will bring imbalance in other facilities investment. Based on the in-depth analysis of Cai [27] of the origin and meaning of the inclusive growth theory, rural policies should focus on the people-oriented concept, address the most urgent needs of farmers, give priority to rural infrastructure construction, and promote the equalization of basic public services between urban and rural areas. In a review report of a series of literature on inclusive growth [16], ADB also has qualitatively studied the relationship between rural infrastructure and inclusive growth, believing that rural infrastructure can promote inclusive growth because it is a prerequisite for individuals to obtain benefits and opportunities from the public resources, especially those vulnerable groups. Jiang et al. [15] measure inclusive growth in China's rural areas from 2004 to 2017, and shows that rural infrastructure plays an important role in supporting inclusive growth in the rural areas. Even though Kanbur and Rauniyar [28] explain the promotion effect of rural infrastructure on the inclusive growth from investment perspective on the microlevel, most of these studies interpret the distribution and supply equity of infrastructure from the macro level, and analysis on the microlevel for such as how a village realizes equity through the WLC of rural infrastructure, regardless of the types, is still missing [29]. Furthermore, there are no clear definitions or indicators to monitor the progress of inclusive growth at the project or program level. The ADB recommends monitoring the implementation of inclusive growth at the country and project levels and suggests that this could be a step toward achieving inclusive growth.

Moreover, in the whole lifecycle of rural infrastructure, studies mainly focus on the innovation of investment and financing mode. Feng et al. [30], Tian and Li [31], and Wang and Zhao [32] all investigate the equity of investment in the rural infrastructure. However, more attention should be paid during the construction, operation, and maintenance phases that do impact farmers a lot. The WLC of rural infrastructure development are lack of farmers' participation [33]. Take rural sanitary for example, spatial equity in rural infrastructure is studied from a microlevel perspective. According to the research results, the main bottleneck of the fairness during rural sanitary construction period base on the large difference in the quality of soft services such as publicity-control in different regions, which leads to the fairness effect of the final sanitary improvement. Therefore, it is necessary to scientifically evaluate the rural infrastructure development inclusiveness during the WLC. The inclusiveness of rural infrastructure here means that each individual can equally enjoy the benefits brought by the development of rural infrastructure in the whole life cycle. And it is important to understand how different factors are forming the impact paths for the WLC of rural infrastructure inclusiveness.

To sum up, in rural areas, no scholars have studied the relationship between infrastructure and inclusive growth from microlevel, as well as the impacting paths of inclusiveness in infrastructure WLC [34]. Therefore, it is desired to analyze the rural infrastructure WLC inclusiveness from the microlevel with constructed and validated impact paths so that future rural infrastructure planning can be more inclusive and helpful in reducing urban and rural gaps.

3. Methodology

3.1. The Whole Picture and This Research. This study is a part of a series of studies (Figure 1). First, through the literature review, the definition of inclusive growth is clarified. Based on the panel data from 2004 to 2017, inclusive growth level in rural China and rural infrastructure construction investment are investigated by combining entropy weight method and TOPSIS, to achieve Goal 1. Second, the influencing factors of rural infrastructure inclusiveness are identified through literature review and analyzing five different types of rural infrastructure projects using grounded theory. This step

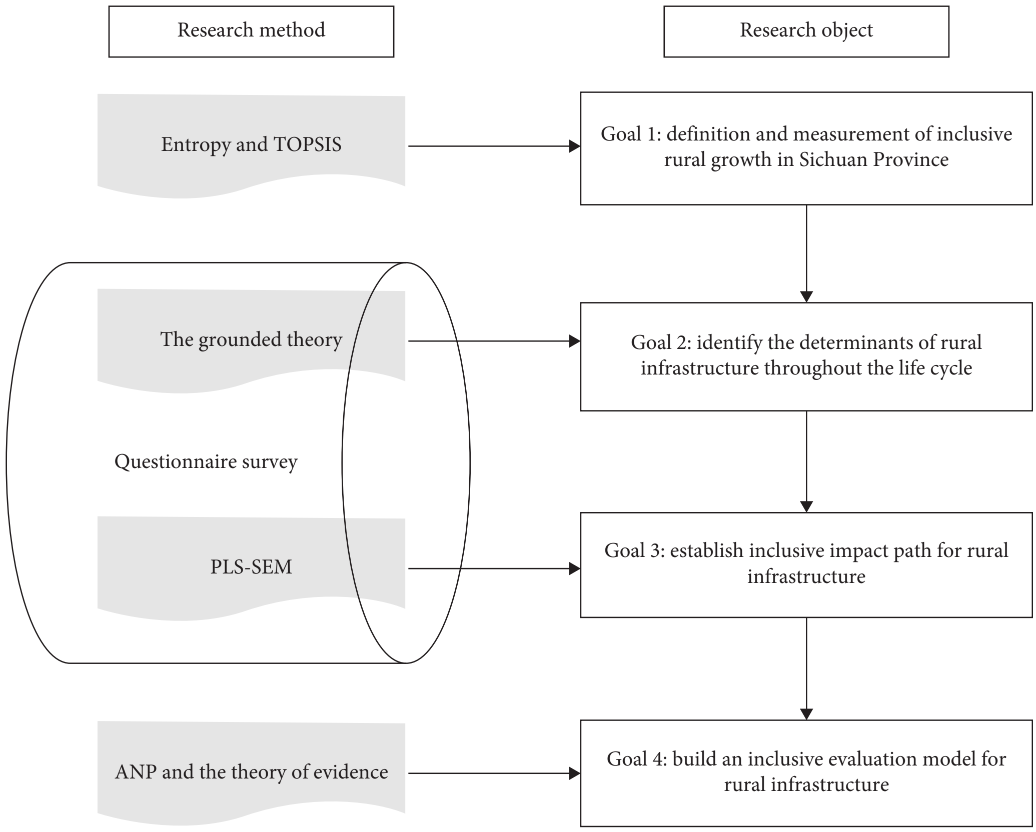

Figure 1: The study series.

achieves Goal 2. Third, based on the identified influencing factors, the logical framework method (LFM) and partial least squares structural equation model (PLS-SEM) are used to explore the impact paths of rural infrastructure inclusiveness to achieve Goal 3 (this paper). Finally, based on the theoretical model, a two-stage evaluation model of rural infrastructure combined with analytical network process (ANP) and evidential reasoning (ER) are constructed, and the effectiveness of the model is verified through empirical research to achieve Goal 4.

As mentioned in the literature review part, there is a lack of research on the inclusiveness definition and impact path (influencing mechanisms) of rural infrastructure on the microlevel for the WLC of rural infrastructure using identified factors. Therefore, this study first established the hypothesis path of the WLC through the (LFM based on the factors groups identified from the previous studies, and then tested the correctness of the hypothesis through PLS-SEM. The reasons for these two steps are:

(1) The LFM was originally developed for US military planning. The United States Agency for International Development (USAID) used LFM in the late 1960s to plan, manage, and monitor international development projects. By the 1990s, this method had been used by the European Commission and numerous large international nongovernmental organizations for the planning, implementation, monitoring, and evaluation of infrastructure development projects, such as agriculture, education, health, and roads [35]. Although the names of the LFM used by the WB for public projects and the design and monitoring framework used by ADB for project performance monitoring system are inconsistent, both of them are based on the LFM method. LFM in strategic planning and project management has shown great effectiveness [36], and is suitable for problem analysis and the establishment of project logical relationship [37]. The core concept of the LFM is the "logical framework" matrix. Matrices enable planners to identify logical connections between methods and results. In the vertical dimension of the matrix, the "outcome chain" describes the project inputs, activities and their expected outputs, outcomes and impacts. On the horizontal dimension of the matrix, columns describe objective verifiable indicators, means of verification, and related conditions of activities and results at each level to assess whether the plan measures the progress of the project (process measures) and whether the progress of the project in turn affects the identified issues (outcome measures) [38]. It is helpful to project management from many aspects, including problem analysis, establishment of project objective level, monitoring and evaluation of project implementation, evaluation after project completion, and so on. Thus, LFM is used to establish a hypothetical path. Since there are different tasks, activities, and objectives during the many stages of the WLC of the rural infrastructure, LFM could help in establishing the logical relationship of different factor groups during different stages through the output effect and influence of the input activities.

(2) SEM is a second-generation statistical analysis technology, which is recognized as the best technology in

analyzing the complex relationship between factors and is widely used in data analysis and processing in management science and engineering [39]. As a second-generation technology and compared with traditional statistical methods, SEM can simultaneously deal with multiple-dependent variables and explore the relationship among numerous-dependent variables. Moreover, independent and dependent variables are allowed to have errors in the statistical process. Two methods are used for estimating the relationship between variables in SEM: one is covariance-based SEM (CB-SEM), which is widely used; and the other is PLS-SEM [40]. PLS-SEM is a prediction-oriented variance-based method, which focuses on the endogenous target structure in the model and aims to maximize its explained variance. Given that PLS-SEM is not based on covariance but reduces the variance of each independent variable, this method has relatively low requirements on measurement scale, sample size, and residual distribution. PLS-SEM is used for analysis based on the number of samples in this study. PLS-SEM quantitative analysis is performed to verify whether the hypothetical relationship between different factor groups established exist, and to verify the specific impact path between different factor groups and the intermediary variables.

3.2. The Influencing Factor Groups of Rural Infrastructure Whole Lifecycle Inclusiveness. In previous works, we have obtained a list of 41 impacting factors on rural infrastructure inclusiveness in China through literature review [41–43]. We have developed a questionnaire survey to measure the relative importance of these factors. 135 Valid replies have been received from the qualified respondents, and statistical analysis has been applied to calculate the importance ranking, average score, and standard deviation of each factor. Factor analysis has been used to reveal potential factor groups. By referring to the factor induction method in the preceding literature, this study divides the 41 factors further into seven groups with high reliability and validity (Figure 2) [44].

3.3. Hypothesis of Impact Paths between Factor Groups in Different Stages. Inclusiveness of infrastructure is closely related to the WLC. In this research, the WLC of rural infrastructure is divided into three stages: investment preresearch, construction, and operation and maintenance stages. The WLC of infrastructure is a dynamic process, and its dynamics is mainly reflected in each stage and the links of activities, with various connections and influences from these factor groups.

Moreover, infrastructure assets are often implemented using projects, which consists of aim, input, output, activities, and influence aspects following the logical framework (LFM). Among them, "aim" refers to the short- or long-term goal of the infrastructure. "Input" refers to the investment of infrastructure resources, such as capital or human resources. "Activities" refer to a series of economic and social activities in the infrastructure realization. "Output" is the result of infrastructure activities, such as the quality of projects. "Influence" is the external effect brought by the infrastructure.

In different stages, the aforementioned correlation is affected by one factor group or multiple factor groups, and has a spillover effect on the next stage [45, 46]. Therefore, the inclusive impact paths of the WLC of rural infrastructure should be constructed by combining the WLC and logical sequences of "aim, input, activities, output, and influence" of the logical framework to establish a three-dimensional framework for the inclusive impact paths of the WLC of rural infrastructure (Figure 3). In the investment preresearch stage, stakeholder equity (STE), project economy (PE), and benefit vulnerable groups (BVG) have a positive impact on inclusive growth. In the construction stage, additional social and economic activities are involved, and nearly all factors at the project and result levels will be considered, including economic development (ED), PE, environmental sustainability (ES), social equity (SE), STE, and project quality (PQ). In the operation and maintenance stage, PQ, BVG, SE, and ES.

According to the previous setting of the theoretical framework for inclusiveness in the WLC of the rural infrastructure, the influence of factor groups on inclusiveness are different and related to the different stages. On the basis of the framework, this study formulates 13 hypotheses based on the relationship among the preceding factor groups (Table 2). Through the 13 hypotheses, the influencing factor group relationship model diagram (Figure 4) is constructed as the original structure diagram.

4. Data Collection

4.1. Data Collection Methods. In this study, structured questionnaires are used to collect sample data [47]. The content of the questionnaire consists of three parts: the first part is the description of the questionnaire, which mainly clarifies the background of the study and introduces the definition of key concepts in this study. The second part is the interviewee's information, which aims to investigate the interviewee's personal industry experience, personal information, and institutions of the interviewee, relevant working years in the rural infrastructure work, and types of rural infrastructure industries involved. The third part is about the importance of influencing factors of the rural infrastructure inclusiveness, which is the core part of the questionnaire.

Respondents need to score the importance of the influencing factors of inclusiveness listed in the questionnaire. The five-level Likert scale (1–5) is used to score, and the scores, respectively, represented the importance level of the factor's influence on inclusiveness. At the same time, in order to verify the accuracy of the factors in the questionnaire again, the scale also set the option of "Not Applicable" when they think that the factor should not be included in the influencing factors.

4.2. Characteristics of the Sample. For survey research, the selection of survey samples is very important. The research objects selected in this study are mainly experts involved in rural infrastructure, the sampling criteria are 30% based on a list of experts in the infrastructure expert pool, and the expert's work experience must include at least 1 year of rural infrastructure construction. In order to select suitable experts to participate in the survey, this study selected two sampling methods, the purpose sampling method and the snowball

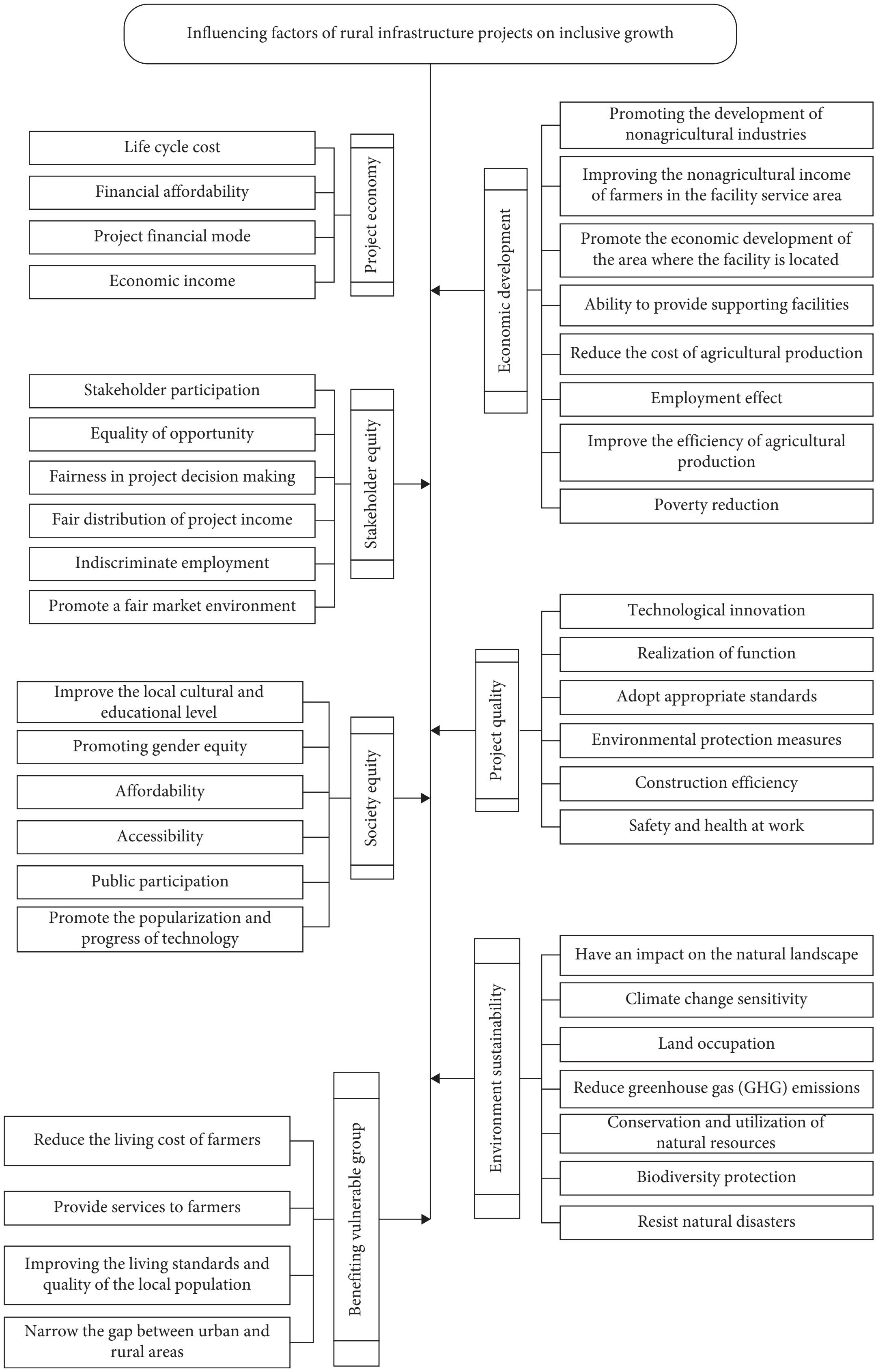

Figure 2: Grouping results of influencing factors.

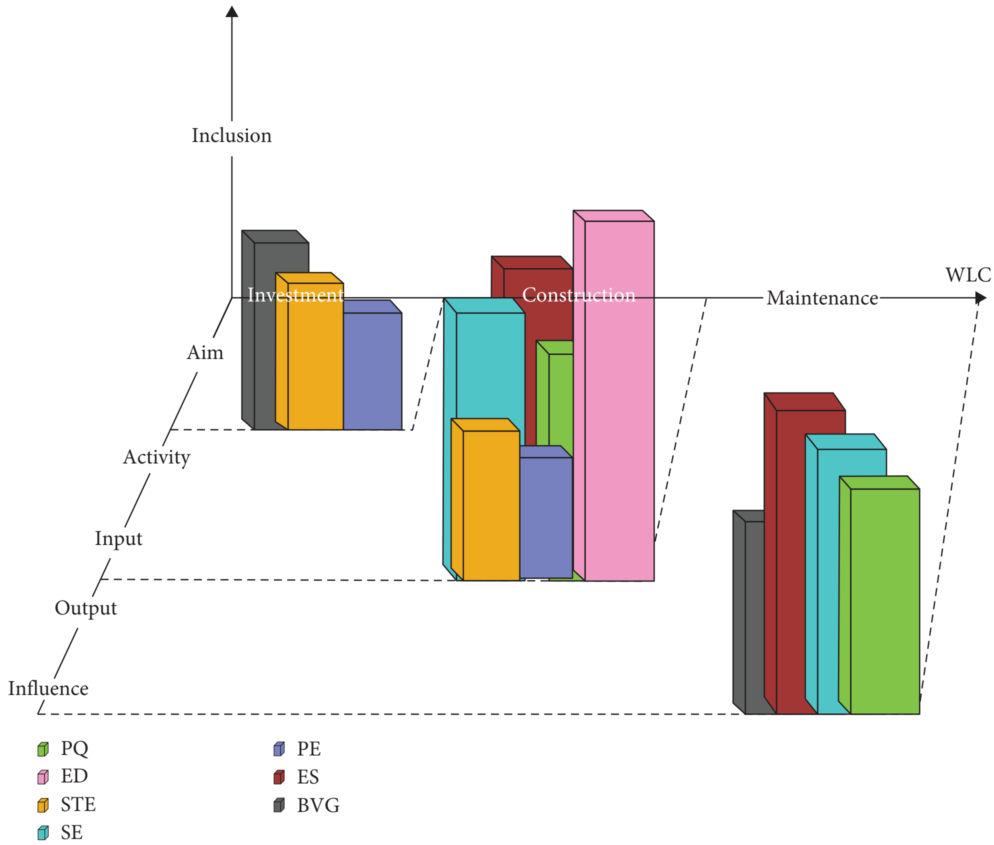

FIGURE 3: Three-dimensional framework diagram of rural infrastructure inclusiveness in the WLC.

TABLE 2: Decision criteria and relationship hypothesis.

No.	Criteria	Hypothesized relationships
1	Aim	Benefiting vulnerable groups (BVG)→social equity (SE)
2	Activity	Stakeholder equity (ste)→benefiting vulnerable groups (BVG)
3		Stakeholder equity (ste)→social equity (SE)
4		Stakeholder equity (ste)→project quality (PQ)
5	Input	Project economy (pe)→economic development (ED)
6		Project economy (pe)→project quality (PQ)
7		Project economy (pe)→social equity (SE)
8		Project quality (pq)→benefiting vulnerable groups (BVG)
9	Output	Project quality (pq)→economic development (ED)
10		Project quality (pq)→social equity (SE)
11		Project quality (pq)→environmental sustainability (ES)
12	Influence	Social equity (se)→economic development (ED)
13		Economic development (ed)→environmental sustainability (ES)

sampling method. The combination of snowball abstraction and purpose sampling method is an ideal method for sample selection. The purpose sampling method is chosen because the author has work experience in the field of infrastructure, and can subjectively select a part of the group as the research object through relevant work experience. However, in order to increase the number of samples as much as possible, snowball sampling is also adopted, by first interviewing a representative expert, then recommended by the interviewee, and then interviewing the second person, and then the second person proceed to visit the third person again, and gradually increase the number of samples by repeating this.

The 135 interviewees participating in this study are from different units and institutions, of which the proportion of interviewees from investors is the highest (31.11%). More than 80% of the interviewees in this study have more than

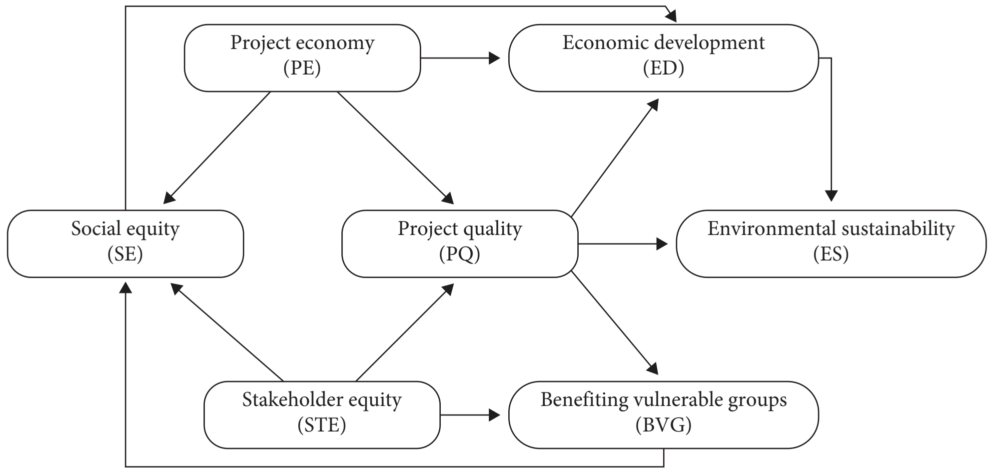

Figure 4: Influence diagram of criteria.

Table 3: The demographic information of the respondents.

Demographic categories	Category	Frequency	Percentage (%)
Type of organization	Research institution	19	14.07
	Design company	7	5.19
	Construction organization	20	14.81
	Investment company	42	31.11
	Government agency	18	13.33
	Consultancy	3	2.96
	Operation organization	22	16.3
Work experience	≤5	22	16.3
	6–10	78	57.78
	11–15	18	13.33
	15–20	9	6.67
	≥20	8	5.93%
Type of projects involved	Rural road	42	31.58*
	Rural power	21	15.79
	Rural waste treat	93	69.92
	Rural health	13	9.77
	Rural telecommunications	8	6.02
	Rural water conservancy and irrigation	32	22.56
	Rural drinking water	33	24.81
	Rural School	18	13.53
	Other	17	12.78

*Note: The type of infrastructure is multiple-choice.

5 years of working experience, of which 57.78% have 6–10 years of working experience. Therefore, most of the respondents have a rich working experience and can represent the opinion of an expert group. Detailed information is listed in Table 3.

4.3. Internal Consistency Reliability Test. In order to verify the validity and reliability of the questionnaire data, it is necessary to test the reliability of the data collected. Like other similar studies, this study chooses Cronbach's alpha coefficient to test the internal consistency reliability of the evaluation scale [48]. The reliability of the overall sample of the questionnaire is 0.95 (Table 4). Therefore, the data collected through this questionnaire has high reliability and can be further analyzed.

Table 4: Cronbach's alpha.

Factors	Sample size	Number of factors	Cronbach's alpha
Overall factors	135	41	0.95

5. Data Analysis for Assumption Testing

5.1. Reliability Detection of Observed Variables. When the external load value of the observed variable is below 0.4, it

Table 5: Measurement model assessment results.

Grouping	Factor code	Factor loading	AVE	CR	Cronbach's alpha
Economic development (ED)	Ec2	0.772	0.571	0.855	0.793
	Ec3	0.749			
	Ec4	0.785			
	Ec6	0.828			
	Ec8	0.615			
Environmental sustainability (ES)	En1	0.668	0.559	0.898	0.867
	En2	0.812			
	En3	0.742			
	En4	0.786			
	En5	0.759			
	En6	0.806			
	En7	0.644			
Social equity (SE)	Sc 1	0.764	0.555	0.882	0.839
	Sc 2	0.717			
	Sc 3	0.694			
	Sc 4	0.712			
	Sc 5	0.786			
	Sc 6	0.791			
Benefiting vulnerable groups (BVG)	Mn1	0.677	0.534	0.82	0.711
	Mn2	0.743			
	Mn3	0.712			
	Mn4	0.785			
Project economy (PE)	Pe1	0.825	0.654	0.883	0.825
	Pe2	0.831			
	Pe3	0.759			
	Pe4	0.816			
Project quality (PQ)	Pm1	0.762	0.652	0.918	0.893
	Pm2	0.789			
	Pm3	0.791			
	Pm4	0.851			
	Pm5	0.781			
	Pm6	0.866			
Stakeholder equity (STE)	Ste1	0.776	0.571	0.889	0.85
	Ste2	0.758			
	Ste3	0.800			
	Ste4	0.754			
	Ste5	0.702			
	Ste6	0.741			

is considered that this variable is unreliable and can be deleted in the measurement model. Whereas if the value is above 0.7, this variable is considered reliable and should be retained. For values between 0.4 and 0.7, the deletion and retention of these variables depend on the average variance extracted (AVE) value. If the AVE value increases and reaches the required critical value after deleting this observation variable, then this variable is deleted, otherwise retained [49]. When multiple observed variables need to be deleted, the variable with the smallest external load value is deleted. In the initial measurement model, the external load of each observed variable is above 0.4, meeting the reservation requirements. However, the AVE value in the dimensions of Economic Development and Project Economy is below 0.5. As such, the factors under these two dimensions should be deleted. The principle of deletion is to delete the first factor according to the load coefficient. After deleting Ec1, Ec5, and Ec7, the external load and AVE value reach the required level. Table 5 shows the left factors after this selection process.

5.2. Path Checking and Discussion. For the evaluation of structural models, PLS-SEM does not depend on any distribution hypothesis. Hence, the standard parameter significance test cannot be used to test the significance of the path coefficient. Instead, researchers must rely on the

Table 6: Path coefficients and significance of the initial model.

Hypothetical path	Path coefficient	T-value	Inference
STE→PQ	0.383	4.951	Support
STE→BVG	0.499	4.663	Support
STE→SE	***0.192***	***1.722***	Not support
PQ→BVG	***0.111***	***0.959***	Not support
PQ→ES	0.558	7.618	Support
PQ→SE	0.323	3.065	Support
PQ→ED	***0.04***	***0.284***	Not support
BVG→SE	0.494	6.629	Support
SE→ED	0.559	6.958	Support
ED→ES	0.212	2.365	Support
PE→PQ	0.483	5.621	Support
PE→SE	−0.209	2.43	Support
PE→ED	***0.14***	***1.11***	Not support

Bold values emphasize that the hypothetical path is "not support".

bootstrapping process to obtain the distribution of statistics. The current study uses bootstrapping technology in testing the significance of path coefficients to determine whether or not the path hypothesis is supported. In the bootstrapping process, subsamples are randomly selected (replaced) from the original data set. Thereafter, each subsample is used to estimate the model. This process will be repeated until numerous random subsamples are produced. Substitution means that every time an observation is randomly sampled from a sampled population, it will be returned to the sampled population before the next observation is sampled (i.e., the population with sampled observations constantly contains all the same elements) [49, 50]. This study sets the number of bootstraps to 5,000 times, and the number of cases is the same as the number of valid samples. Moreover, the T value of the double-tail T test was 1.96 (significance level was 0.05). Table 6 lists the specific values of the path. Four of the 13 paths are rejected, and the other paths are supported.

"Project quality→Environmental sustainability" path discusses relationship between these two groups of factors on the output level at the operation stage. Path coefficient of "project quality→environmental sustainability" has the highest T value among all path coefficients, indicating that the engineering quality of rural infrastructure has the most significant impact on the environmental sustainability, and is similar to the research conclusion in traditional research [51]. Numerous studies have discussed the performance and methods of environmental management in project management. Owing to the large consumption of natural resources, the construction field should considerably focus on environmental protection measures in construction compared with the other industries. Similarly, the construction of rural infrastructure will considerably use the existing rural natural resources, which will produce huge pressure on the bearing capacity of rural resources. From the project level, project quality and services have the most impact on environmental sustainability. Thus, rural infrastructure projects should considerably focus on environmental protection measures in the project.

"Social Equity→Economic Development" path discusses the relationship between social equity and economic development on the influence level at the maintenance stage. Social equity has a direct impact on economic development, which is consistent with the research conclusion at the macro level [52]. At the outcome level, social equity significantly affects the level of economic development. Hence, social equity should be prioritized when promoting economic development through infrastructure. Given that benefiting vulnerable groups has a direct impact on social equity, we should focus on benefiting vulnerable groups [53].

"Stakeholder Equity→Benefiting Vulnerable Groups" path discusses the relationship between these two groups of factors on the activity level at the construction stage. It shows that stakeholder activities at the project level have an impact on benefiting vulnerable groups, while these groups have an impact on social equity at the outcome level. Therefore, benefiting vulnerable groups can have a direct impact on the outcome of the variable and is also an important intermediary variable that the project level variables have an impact on the outcome level. Vulnerable groups as part of stakeholders, only when they are fully included in the activity process, can the facilities consider the demands and goals of different groups in the entire process.

"Benefiting Vulnerable Groups→Social Equity" path discusses the relationship between these two groups of factors on the aim level at the investment stage. The relationship between benefiting vulnerable groups and social equity is evident. Vulnerable groups cannot fully enjoy social resources because of their own poverty in resources and abilities, leading to the concentration of resources in the hands of groups with substantial capital. Even if opportunities are equal, vulnerable groups cannot participate in and benefit from the opportunities provided by the growth process for various reasons. Therefore, to avoid policy failure, the policy objectives of vulnerable groups should be considered to bring social equity.

"Stakeholder Equity→Project Quality" path discusses the relationship between these two groups of factors on the activity level at the construction stage. Project stakeholders often include contract authorizing institutions, private investors, suppliers, customers, employes, civil society groups, and local communities. When continuous communication, trust, and open cooperation are maintained among stakeholders, the promotion of projects will be effective. This relationship is established and maintained on the basis of stakeholders benefitting fairly and fully from the project arrangement. Moreover, when project stakeholders fully participate in all aspects of projects, balanced needs and participation of stakeholders will affect the promotion of projects [54, 55].

"Project economy→project quality" path discusses the relationship between these two groups of factors on the input level at the construction stage. PE is closely related to the project quality [14]. Costs and benefits of different stages determine the overall return level, thereby promoting the use of superior and considerably efficient technologies in the project. This aspect is also an important guarantee for the smooth implementation and sustainable operation of the project. Good project quality will ensure the good use of facilities in the operation and maintenance stage, and reduce the cost of maintenance and operation. However, infrastructure is considered by the investors in maintaining an appropriate level of return on investment facilities as a requirement to meet socioeconomic standard need to minimize costs [56]. If the income level of infrastructure projects is low, then it cannot be implemented smoothly, and attracting suitable social capital to develop and operate is difficult to achieve [57].

"Project Economy→Social Equity" path discusses the relationship between these two groups of factors on the input level at the construction stage. If projects cannot set reasonable income levels or control the appropriate costs, then the results are excessive demand, significant pollution, and improper allocation of public funds leading to underpriced public services. Moreover, excessive prices will exclude low-income users. The participation of social capital is crucial for the scale of infrastructure. Otherwise, realizing the scale of infrastructure purely through public funds is impossible to achieve [57]. Advanced financing mode can solve the problem of insufficient participation of social capital, bring markedly efficient social capital, and reduce the commercial reasons for insufficient investment in infrastructure owing to low returns and risks. Accordingly, the scale of facilities, regional scope of benefits, and number of people covered are increased.

"Project Quality→Social Equity" path discusses the relationship between these two groups of factors on the output level at the maintenance stage. High-quality facilities have effectively changed the quality of life of local farmers and provided opportunities for them to obtain high-quality educational and medical resources. Employes' occupational security and health should be highly valued, and local workers should receive reasonable wages, which will bring social stability.

"Economic Development→Environmental Sustainability" path discusses the relationship between these two groups of factors on the influence level at the maintenance stage. The relationship between economic development and environmental sustainability is widely discussed that economic development may result in environmental change.

6. Conclusions

This study is a part of a series of studies which try to fill the gap of understanding Chinese rural infrastructure inclusive growth on microlevel during the WLC with influencing factors identification and grouping and hypothesis making and validation. This study has combined first WLC of infrastructure assets with logical framework to construct the analysis framework, which is used as a basis to develop hypothesis on impact paths. This study further applied structural equation modeling for validating impact paths for rural infrastructure inclusiveness. Questionnaires were designed and data were collected for further analysis. According to the final results, 9 of the 13 hypothetical paths are verified, and the final relationship models of seven factor groups affecting inclusiveness are determined. Through structural equation modeling, the influence mechanism of rural infrastructure inclusiveness at microlevel is constructed. Rural infrastructure inclusiveness has different impacts on the WLC inclusiveness of rural infrastructure. According to the theoretical model, the "project economy," "project quality," and "stakeholder equity" of infrastructure at the project level all have an impact on the "social equity," "economic growth," and "environmental sustainability" at the outcome level. There are nine paths among the factor groups, which reflect the influence mechanism of rural infrastructure inclusiveness at the microlevel, among which "project quality" has the most significant influence on "environmental sustainability." The above path relationship verifies the hypothesis put forward.

Concluded from the above statements, at the macro perspective, social equity is a prerequisite for economic development and the core meaning of inclusiveness. Based on the research findings, the four recommendations below are made to improve the inclusivity of rural infrastructure. First, at the outcome level, social equity significantly affects the level of economic development. As a result, when promoting economic development through infrastructure, social equity must be prioritized in both macro and micro areas, and rural infrastructure evaluation should include indicators that match social equity, such as accessibility and accessibility, to encourage project implementers to fully consider social equity. Second, project quality and stakeholder activities have a direct impact on economic development and social equity. The engineering quality of rural infrastructure will also ultimately affect the life of the facility and the experience of users. At each stage, we should start from different perspectives and pay attention to the overall level of inclusiveness of the facility. Farmers must be fully involved in the entire life cycle of infrastructure so that the facilities can be used by farmers in the end. The construction and design of facilities should use advanced technology as much as possible. The quality of rural infrastructure projects and the participation of farmers must be fully considered in the construction, especially the full participation of farmers throughout the life cycle of the infrastructure so that the facilities can eventually be used by farmers. Third, because rural infrastructure generally faces financing difficulties and short-term problems in operation and maintenance, therefore, it is essential to fully establish a reasonable capital introduction model for building rural infrastructure and pay attention to cost control throughout the entire life cycle to address the lack of funds for high-quality engineering construction as well as operation and maintenance. At last, the rural environmental capacity is not optimistic. The construction of rural infrastructure must consider the environmental impact, use existing resources on the spot, and protect the rural ecological environment.

This study contributes to the following areas. First, this study applies the theory of "inclusive growth" to the field of infrastructure management. Inclusive growth, as a frontier proposition in development economics, has not been widely used and studied in both macro and micro practice. Second, this study establishes the theoretical framework of rural infrastructure inclusiveness through the combination of qualitative and quantitative research. Furthermore, the concept of inclusive growth is combined with the implementation of infrastructure, which expands the extension of inclusive growth and puts forward a theoretical framework for the WLC management of rural infrastructure at the microlevel. Third, through LFM and PLS-SEM methods, the formation and validation of impact paths of rural infrastructure inclusiveness at the microlevel are established and explained. Even though there have been a lot of research achievements in urban infrastructure evaluation, including sustainability, performance evaluation, and project evaluation, but there are not many evaluation methods for the rural infrastructure. There are no evaluation studies on the characteristics, implementation norms and implementation purposes of the rural infrastructure. Based on the evaluation of rural infrastructure projects and the analysis results, specific suggestions for policies are provided which forms decision-making basis for governments in the WLC of rural infrastructure.

Data Availability

This paper adopts the research method of questionnaire survey. All data generated or analyzed during this study are included in this published article.

Ethical Approval

All experimental protocols were approved by Sichuan University and Chengdu University of Information Technology. All methods were carried out in accordance with relevant guidelines and regulations.

Consent

All the questionnaire results will be used for scientific research, and informed consent was obtained from all interviewees.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Aichun Jiang, Yibin Ao, Ruo Yang, and Tong Wang wrote the main manuscript text. All authors reviewed the manuscript.

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