

# A Rural Road Construction and Investment Effect Evaluation System in China

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**Abstract**—Developing rural road is an important policy in the field of transportation in China since the 21st century. During the 13th Five Year Plan period, the average annual investment in rural road construction is about 445 billion yuan. In accordance with the requirements of promoting the modernization of national governance capacity and implementing the performance evaluation of major policies, it is necessary to carry out the evaluation of rural road construction and investment effect. Based on the characteristics of China's rural road development and related policies, and with reference to the evaluation methods of other industries' major policy effects, this paper establishes an evaluation system for rural road construction and investment effects, including evaluation index system, index calculation method and index weight determination method. This method can be used to compare the development of rural roads in a certain region with the benchmark, find the advantages and disadvantages, and provide the basis for policy improvement.

**Keywords:** *evaluation, rural road, investment, poverty alleviation*

## I. INTRODUCTION

Rural road is an important part of road network and one of the most important infrastructures to ensure rural economic and social development in China [1]. Since 2003, in order to improve traffic conditions in rural areas, China has significantly increased investment in rural roads. Especially since 2011, rural road development has focused on solving the problem of rural accessibility, and effectively supported the completion of poverty alleviation task.

The implementation of budget performance management is the requirement of promoting the modernization of national governance system and governance ability, and is the important content of deepening the reform of financial and tax system and establishing modern financial system [2]. In order to carry out the requirements of implementing budget performance management in an all-round way, we should speed up the establishment of a budget performance management system

with all aspects, all processes and all coverage, so as to improve the efficiency of financial resource allocation and use efficiency, and enhance the public trust and execution of the government [3]. China's Ministry of transport requires government departments to evaluate major industry policies, timely grasp the implementation and effect of policies, and enhance the effectiveness of policies. Rural road construction is one of the major policies in the transportation industry, which involves a wide range and has a large amount of investment. During the 13th Five Year Plan period, the annual investment in rural road construction in China is about 445 billion yuan, of which about 100 billion yuan is invested by the central government. Therefore, it is necessary to evaluate the effect of rural road development, summarize experience, find out problems, put forward corresponding countermeasures, and continuously improve relevant policies. At present, in the field of performance evaluation, there is a lack of special evaluation of rural road development effect, and a mature evaluation system has not been formed. Based on the characteristics of rural road development and the evaluation methods of other major policies, this paper establishes the evaluation system of rural road construction and investment effect, including evaluation index system, index calculation method and weight determination method.

## II. CONSTRUCTION OF EVALUATION INDEX SYSTEM

### A. Principles of index system

The method of comprehensive evaluation index system is suitable for evaluating the effect of rural road construction and investment. The purpose of rural road construction and investment effect evaluation is to track the achievements of rural road development and evaluate the effect. The index system must follow the following principles to ensure it scientific and practical.

The index system should be comprehensive. Rural road construction and investment involve a wide range, the

evaluation index system should be comprehensive and systematic, and key factors should be considered from multiple perspectives.

The key points should be highlighted in the index system. On the premise of ensuring the integrity, select key indicators and keep the simplicity of the indicator system.

Indicators should be comparable. The effect evaluation of rural road construction and investment in a certain region is based on the comparison with other regions, so the indicators should be comparable.

Index data shall be easy to obtain. Try to select indicators that can be obtained or measured from statistical data to reduce the difficulty of data collection.

Indicators should be independent. The indicators should avoid overlapping and repetition, which will affect the rationality of the evaluation results.

**B. Index system construction**

The index system is very important to the evaluation system. The first step of the general procedure is to define the overall objective of the evaluation, decompose the overall objective and propose the primary index. Then according to the principle of index system construction, the primary indexes are selected to form the final evaluation index system.

According to the principle of comprehensive performance management, major policy evaluation should pay attention to both direct achievements and indirect effects. The direct achievements of rural road construction and investment are reflected in the improvement of traffic conditions in rural areas, and the indirect effects are reflected in the impact on the economy and society, the effect of poverty alleviation, etc. Based on this, we think that the evaluation can be made from four aspects: construction achievements, investment

completion, improvement of traffic conditions, and service to economic and social development. The four aspects are further decomposed and the evaluation indexes are preliminarily selected.

In the index selecting stage, the common Delphi method can be used. Traffic experts, economic experts and poverty alleviation experts can be invited to rate the importance of each indicator. Delete indicators with importance lower than 60%. Then the remaining indicators are scored again according to the importance, and the indicators are filtered again according to the scoring data. The steps are shown in "Fig. 1" [4]. The evaluation index system finally established by this method includes three levels and 20 indexes, as shown in "Table I".

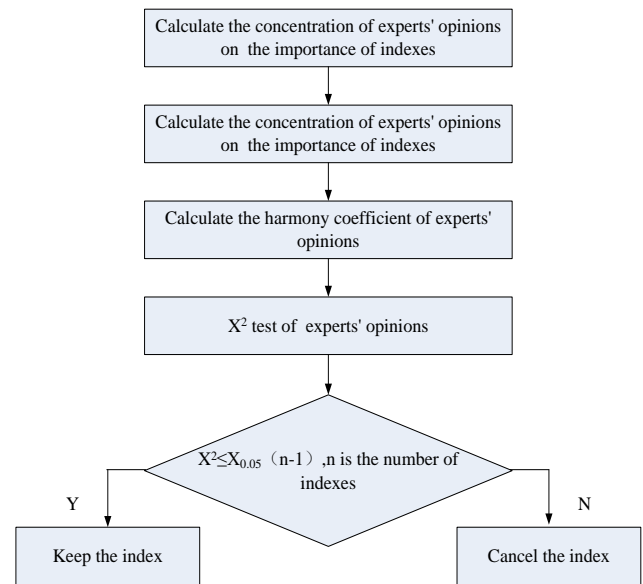


Fig. 1. Steps of selecting indexes.

TABLE I. EVALUATION INDEX SYSTEM OF RURAL ROAD CONSTRUCTION AND INVESTMENT

Level 1	Level 2	Indexes
Construction achievement	Scale of rural roads	Mileage of new or reconstructed rural roads
	Quality of rural road	Rural road density
		Proportion of grade rural roads
		Proportion of rural roads above grade II
		Mileage proportion of rural roads with hardened pavement <sup>a</sup>
	Accessibility of rural road	Proportion of villages with roads
Investment	N/A	Proportion of villages with hardened pavement roads
		Investment of rural roads
		Proportion of rural road investment in the whole road investment
Improvement of traffic conditions	Improvement of travel conditions	Proportion of villages and towns with passenger buses
	Improvement of logistics conditions	Average car ownership per rural household
		Proportion of towns with logistics nodes
Economic and social development promotion	Poverty alleviation effect	Proportion of towns with express delivery nodes
		Growth of per capita disposable income of rural residents in poor areas
		Decline of number of the poor population
	Economic pulling effect	Decline of poverty incidence
		Direct contribution rate of rural road investment to GDP
	Employment promotion effect	Contribution rate of rural road investment to employment
	Consumption promotion	Growth rate of per capita consumption
	Decrease of Engel coefficient	

<sup>a</sup>. Hardened pavement road refers to the road paved with asphalt or concrete.

III. INDEX CALCULATION METHOD

The interpretation and calculation methods of some indexes are as follows.

Rural road density= total mileage of rural roads/ area.

Proportion of grade rural roads= mileage of rural roads with technical level of 4 or above/ total mileage of rural roads.

Proportion of villages with roads = number of villages with road/ total number of villages.

Proportion of towns with logistics nodes = number of towns with logistics nodes / total number of towns.

The direct contribution rate of rural road investment to GDP can be calculated by regional input-output data. Direct contribution rate of rural road investment to GDP = direct contribution amount of rural road investment to GDP / total GDP. Using input-output data to calculate the contribution of rural road investment to GDP needs data preparation. Use statistical data or sampling survey data to split the investment direction of rural road investment, such as the investment in road construction industry, the investment in transportation equipment manufacturing industry. Then the contribution of different investment to GDP is calculated. Taking the road construction industry as an example, the direct contribution of road construction investment to GDP can be calculated as follows.

$$\Delta Y = (I - A)^{-1} \times \Delta X = (\Delta Y_1, \Delta Y_2, \dots, \Delta Y_n)^T \quad (1)$$

$$\Delta X_1 = (\Delta Y_1, \Delta Y_2, \dots, \Delta Y_n) \times (a_1, a_2, \dots, a_n)^T \quad (2)$$

$$\Delta Y_1 = (I - A)^{-1} \times \Delta X_1 = (\Delta Y_1^1, \Delta Y_2^1, \dots, \Delta Y_n^1)^T \quad (3)$$

$$Y_1 = \Delta Y_1^1 + \Delta Y_2^1 + \dots + \Delta Y_n^1 \quad (4)$$

In these formulas, ΔY is the direct pulling effect of road construction investment on other industries and I is the unit matrix. A is the direct consumption coefficient matrix and ai is the pull coefficient of the i industry sector to the output of road construction industry, that is, the complete consumption coefficient of other industries to road construction industry. ΔY1 is the added value of output of various industries caused by the direct pulling effect of investment. ΔX1 is the output increase of highway construction industry caused by the increase of various industrial sectors. ΔY1 is the influence of road construction investment on various industries through multiplier effect. Y1 is the influence of road construction investment on national economy through multiplier effect [5].

The contribution rate of rural road investment to employment is also calculated by regional input-output data.

IV. INDEX WEIGHT DETERMINATION METHOD

The weight of each index will affect the final evaluation results. Determining the weight of indexes is one of the key links in the construction of index system. Comparing the applicability, advantages and disadvantages of various methods to determine the index weight, it is recommended to

use AHP to determine the index weight. This method can not only consider the subjective judgment of professionals, but also offset the bias of some subjective factors by mathematical method. At the same time, this method has less dependence on data and it is simple to do [6]. The process of determining index weight by AHP is shown in "Fig. 2".

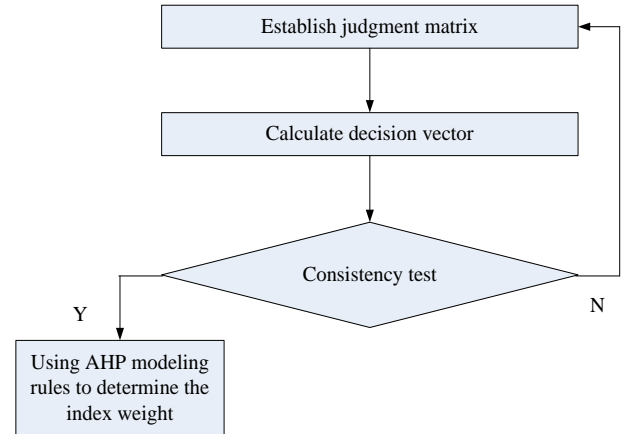


Fig. 2. Steps of calculating index weight.

A. Establishing judgment matrix

Compare two indexes of the same level, evaluate the grade according to their importance, and form the judgment matrix. aij is the comparison result of the importance of index i and index j. The matrix formed by the comparison of two indexes is called judgment matrix. Judgment matrix has a property as equation (5) shows.

$$A_{ij} = 1/A_{ji} \quad (5)$$

B. Hierarchical single ordering and its consistency test

The eigenvector corresponding to the largest eigenvalue of the judgment matrix λmax is recorded as w after normalization. The element of W is the weight of the relative importance of the same level index to the previous level index. This process is called hierarchical single ordering. Consistency inspection is required to confirm the hierarchical single ordering.

Ci is defined as the consistency indicator, and CI is calculated as follows.

$$CI = (\lambda - n)/(n - 1) \quad (6)$$

If CI = 0, the ordering results are completely consistent. If CI is close to 0, the ordering results have satisfactory consistency. The larger the CI, the more serious the inconsistency is. In order to measure the size of Ci, the random consistency index RI is introduced.

$$RI = (CI_1 + CI_2 + \dots + CI_n)/n \quad (7)$$

RI is related to the order of judgment matrix. In general, the larger the matrix order is, the greater the probability of

random deviation of consistency is. The corresponding relationship is shown in "Table II".

TABLE II. STANDARD VALUE FOR RI

Matrix Order	1	2	3	4	5	6	7	8
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41

By comparing CI with RI, the test coefficient CR is obtained. The equation is as follows.

$$CR = CI/RI \tag{8}$$

Generally, if  $CR < 0.1$ , the judgment matrix is considered to have passed the consistency test, otherwise it will not have satisfactory consistency.

*C. Hierarchical total ordering and its consistency test*

Calculating the weight of the relative importance of all the factors of a certain level to the highest level is called the total hierarchy ordering. This process is from the highest level to the lowest level.

V. CONCLUSION

The research has established a basic rural road construction and investment evaluation system, which has a wide range of applicability. In application, we can evaluate a province or an economic region such as the central region. In order to find out which aspects of rural road development in a certain region are advantages, which aspects are disadvantages and how much the gap is, we need to choose a reasonable benchmark. The benchmark can be the province with outstanding rural road construction and investment, or the national average level.

When applying this evaluation system, each region can also adjust and optimize the evaluation indexes according to the actual situation, so that the evaluation index system is more applicable and the evaluation results are more conducive to the optimization of policies.

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