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Research on the Construction of "New Infrastructure" Project Performance Evaluation Index System

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Abstract

New infrastructure construction is an expansion of traditional infrastructure, taking into account the dual tasks of "stabilizing growth" and "promoting innovation". This study adopts the logical framework method and comparative analysis method, according to the relevant principles of the construction of the "new infrastructure" project performance evaluation index system, and improves the design ideas on the basis of the traditional infrastructure project performance evaluation index system. This paper forms four major categories of indicators including the project objective evaluation, project feasibility evaluation, project construction stage evaluation and project post-stage evaluation, 23 indicator sub-categories and 127 specific indicators, and builds a scientific, reasonable and practical "new infrastructure" project performance evaluation indicator system.

Keywords

New infrastructure; Performance evaluation; Index system.

1. Introduction

Infrastructure construction is a key link in the process of urbanization, it is the mainstay of the people's livelihood and socioeconomic development. Since the reform and opening up, our country's infrastructure construction has developed rapidly, and has played a significant role in driving economic growth. Traditional infrastructure in various regions has been improved day by day. [1] At the end of 2018, the Central Economic Work Conference first proposed the positioning of construction of new infrastructure was subsequently mentioned many times in government work reports, the executive meeting of the State Council, and the meetings of the Standing Committee of the Political Bureau of the Central Committee. Affected by the superimposed impact of Sino-US trade frictions and shifts in China's economic growth, especially the spread of the global new crown epidemic (2019-COVID), the global economy is in deep recession, and our country's economic development is facing greater pressure. The State Council's Government Work Report in 2020 Proposed to focus on supporting the "two new and one heavy" (new infrastructure construction, new urbanization construction, transportation, water conservancy and other major construction projects)[2]. The "New Infrastructure" project is of great significance for promoting high-quality economic development and implementing innovation-driven development strategies. Through "new infrastructure" to deal with economic and financial crises and turn crises into opportunities, a series of macro hedging policies to expand consumption, investment and domestic demand have been formed.

Because "infrastructure" projects have the characteristics of long investment cycle, huge cost, high risk, and large scope of influence, each project needs to be carefully considered and strictly evaluated before implementation. "New infrastructure" is the replacement of traditional infrastructure. It is different from traditional "infrastructure". "New infrastructure" mainly

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focuses on technology, but it also has the similar characteristics of traditional infrastructure. Affected by factors such as the level of regional economic development and the degree of infrastructure perfection, various localities have formed different emphasis on the promotion of "new infrastructure" plans. A series of issues such as how to formulate the "new infrastructure" project, how to advance it, and how to evaluate it has become an urgent problem in practice.

2. Theoretical Summary and Questions

2.1. Concept Definition

Infrastructure refers to the municipal public engineering facilities and public life service facilities provided for social production and people, including transportation, post and telecommunications, water supply and power supply, commercial services, scientific research and technical services, landscaping, environmental protection, culture and education, health services, etc.. Traditional infrastructure construction mainly refers to the "iron public foundation", including major infrastructure constructions such as railways, highways, bridges, and water conservancy projects. Compared with the traditional infrastructure, "new infrastructure" provides a new direction, which refers to the infrastructure construction based on science and technology, covering seven major fields: 5g infrastructure, UHV, intercity high-speed railway and intercity rail transit, new energy vehicle charging pile, big data center, artificial intelligence and industrial Internet[3]. It mainly includes three aspects: information infrastructure, integration infrastructure, and innovation infrastructure. The construction of a scientific and technological innovation system provides protection for the external support facilities and internal operation integration facilities of the infrastructure. The scientific and technological innovation ecosystem, which is organically integrated by the legal policy system, human resources, financial capital, social environment, basic research, R&D centers, and new innovation integrated platforms, will provide basic guarantee for the "new infrastructure".

2.2. Current Research Status at Home and Abroad

For the infrastructure construction project performance evaluation index system, domestic and foreign scholars have studied it from different perspectives. For example, domestic scholar Yuan Jingfeng et al. (2012) used key performance evaluation indicators and guided by VFM to study the construction of performance evaluation indicators for international infrastructure construction PPP projects[4]. Xue Saijun (2016) constructed a performance audit evaluation index system for government investment construction projects from the perspective of project life cycle theory[5]. Li Qian et al. (2018) took infrastructure projects under the background of new urbanization as the research object, and constructed a performance evaluation index system including 5 modules[6]. Wang Qi (2019) conducted an in-depth study on the life cycle performance evaluation system of infrastructure projects from the perspective of government-paid PPP project performance evaluation[7].

Foreign scholars have carried out extensive research on performance evaluation, especially the performance evaluation of infrastructure projects. For example, Kenneth (1975) believes that the result of performance evaluation is the value judgment of management ability and project efficiency in project construction, which can objectively reflect the project operation output and the quality of services provided to the society[8]. Osborne et al. (1992) believe that performance evaluation is a judgment of the value of construction results, not just focusing on the process of public infrastructure projects[9]. James (1989) believes that performance evaluation should be based on the cost of human, material, and financial resources consumed as the standard, and the economic behavior of evaluating government performance based on the construction results of public infrastructure projects[10]. In the relevant exploration and

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research of domestic and foreign scholars, project performance evaluation has gradually formed a relatively systematic and complete indicator system. Taken together, it mainly includes three parts: evaluation indicators at the project feasibility analysis stage, evaluation indicators at the project construction stage, and post-project evaluation indicators, which constitute the main framework of the international project performance evaluation indicator system.

2.3. Question Asked

Based on the research of the literature both in China and aboard, it can be found that the experts have conducted in-depth analysis on the performance evaluation index system of traditional infrastructure. However, there are very few relevant studies on "new infrastructure" that are significantly different from traditional infrastructure. Based on this situation, the core question raised by this research is how to construct a performance evaluation index system for "new infrastructure" projects? Specifically, can the performance evaluation indicators of "new infrastructure" projects copy the performance evaluation indicator system of traditional infrastructure projects? Regarding the new characteristics of "new infrastructure", how to improve the performance evaluation index system? This research uses the logical framework method and comparative analysis method to clearly define the relevant concepts. According to the relevant principles of the construction of the performance evaluation index system of the "new infrastructure" project, the design indicators are improved on the basis of the traditional infrastructure project performance evaluation index system, and it is planned to construct a A scientific, reasonable and practical performance evaluation index system for "new infrastructure" projects.

3. Principles for the Construction of Performance Evaluation Index System for "New Infrastructure" Projects

Constructing a complete and feasible performance evaluation index system for infrastructure construction projects is of great significance for carrying out project evaluation. When constructing the evaluation index system, the following principles should be mainly considered:

3.1. “Third Party" Principle/Principle of Objectivity

In the process of constructing the performance evaluation index system of the “new infrastructure” project, it is necessary to ensure the scientific rationality of the collection of data, the methods used and the evaluation results and other processes, maintain an objective and neutral attitude, and enhance the credibility and reliability of the evaluation indicators.

3.2. The Principle of Fairness

First, the evaluation index must adhere to the principle of fairness and fairness, objectively reflect the actual situation, and fairly evaluate the operation status of the project. Second, use a generally recognized reference system, because the reference system selected based on the industry and geographic information of the project can make the evaluation conclusions reliable and reliable.

3.3. The Principle of Quantification

Any indicator is guaranteed to be quantifiable and objective. In other words, project performance evaluation indicators must have certain measurement standards to ensure the reliability and validity of the indicators. Reliability reflects the degree of consistency of the evaluation results; validity reflects the objectivity and validity of the evaluation results.

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3.4. Principle of Integrity

Project performance evaluation needs to evaluate all aspects and stages of the project, and set relevant indicators according to the preliminary analysis phase of the project, the mid-term evaluation phase of the project construction, and the post-project evaluation phase. The entire project performance evaluation index system must have a complete framework and clear structure.

3.5. Principle of Comprehensiveness

The comprehensive indicator system should cover the degree of achievement and impact of various objectives of project construction, adhere to the "5E" (ie fairness, efficiency, effectiveness, economic and environmental principles) principles of performance evaluation, and pursue the For the comprehensive realization of multiple goals such as safety and performance, the weight of each indicator in the performance evaluation is reasonably configured according to the specific time point of the evaluation.

3.6. The Principle of Combining Qualitative and Quantitative

All evaluation indicators must be based on various qualitative and quantitative textual content or data to verify whether the data forming the basis of the evaluation are true, accurate, and in line with the actual situation of the project. In the implementation of performance evaluation, it is necessary to pay attention to both qualitative evaluation and quantitative analysis with accurate data. The two complement each other to have clear standards and stronger persuasiveness.

4. Design Ideas of Performance Evaluation Index System for "New Infrastructure" Projects

As the evaluation of infrastructure construction projects has received more and more attention in public management, project evaluation has developed from a single economic evaluation to cover all aspects of economy, technology, environment and society. However, economic and technical evaluation is still the foundation, the project decision sequence proposed by the World Commission on Dams (WCD) is social evaluation, ecological environment evaluation, economic and financial evaluation, management evaluation and technical evaluation, which provides new ideas for the performance evaluation indicators of developed countries and international projects. The performance evaluation index system of traditional infrastructure projects in China has been gradually improved in previous research and project practice, and the main evaluation indicators and evaluation parameters have been basically established. In 2006, the "Economic Evaluation Methods and Parameters of Construction Projects" (third edition) compiled by the Ministry of Construction of the National Development and Reform Commission was published. The main content includes three parts, including the financial, risk, and economic impact of construction projects, as well as financial evaluation parameters and national economy. The evaluation parameters are introduced in detail[11]. In addition, different types of projects have formed a certain continuity of project performance evaluation index systems according to their own characteristics.

The academic community has basically reached a consensus on the project evaluation index system, which is generally evaluated from five aspects: financial benefits, national economic benefits, social benefits, environmental benefits and sustainable benefits. The performance evaluation indicators of traditional infrastructure projects are also based on these five aspects. Different from traditional infrastructure, the “new infrastructure” focuses on the development of the technology side, mainly including infrastructure projects with new-generation technical and social characteristics. "New infrastructure" has the advantages of a long industrial chain and great driving force, and its development still needs to rely on the support of many types of

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traditional infrastructure industries such as construction, building materials, engineering machinery and equipment. Therefore, this research will build on the performance evaluation index system of traditional infrastructure projects to further build the performance evaluation index system of "new infrastructure" projects.

Logical Framework Method (LFA) is a method developed and used by USAID for design, planning and evaluation. The method starts with determining the core problems to be solved, and expands upward step by step to obtain its influence and consequences, and then deduces step by step to find out the reasons and obtain the "problem tree". By transforming the problem tree, the causal relationship described by the problem tree is transformed into the corresponding means-target relationship, and the so-called target tree is obtained. After obtaining the target tree, complete further work through the "Planning Matrix"[12]. The vertical logical relationship of new infrastructure construction projects is shown in Figure 1.

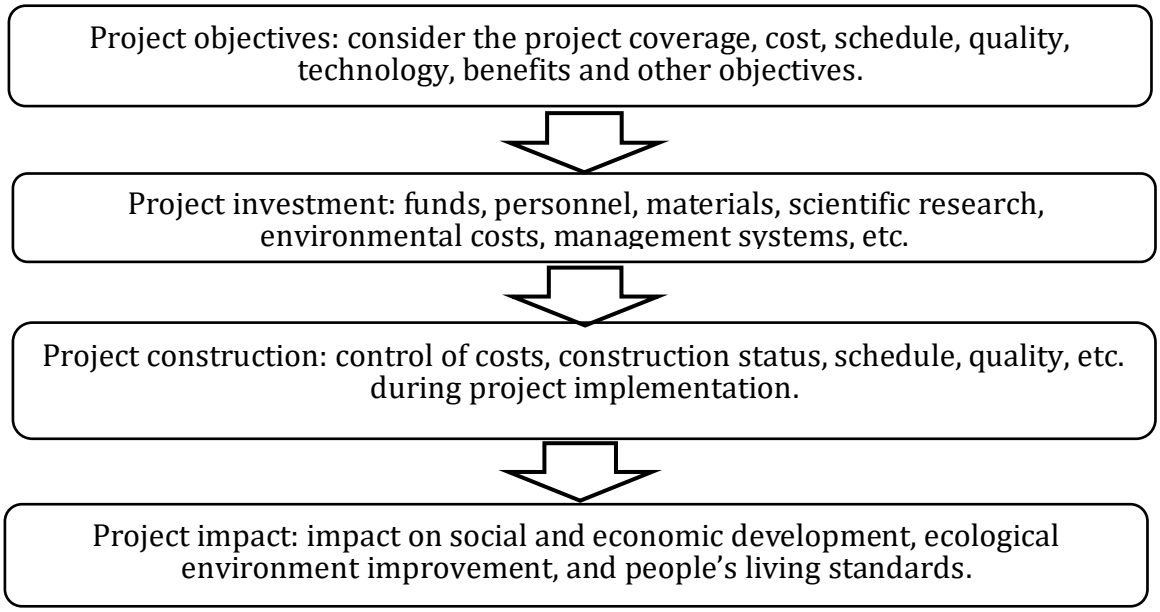

Fig 1. "New Infrastructure" project vertical logical relationship diagram

Furthermore, on the basis of the vertical logical relationship of the "new infrastructure" project, the target level and content are transformed into the target level and measurement level for constructing performance evaluation. The conversion result is shown in Figure 2.

It can be seen from Figure 2 that the performance evaluation index system obtained from the logical relationship transformation of the "new infrastructure" project covers four parts: project objective evaluation, project feasibility evaluation, project construction stage evaluation and post-project stage evaluation. These four parts can reflect the whole life cycle of the project. So this study divides the performance evaluation index system of "New Infrastructure" project into four major categories, and on this basis, subdivides and measures its sub-categories and specific indicators.

5. Construction of the Performance Evaluation Index System for "New Infrastructure" Projects

Referring to China's "Economic Evaluation Methods and Parameters of Construction Projects", "Evaluation Methods of Science and Technology" and the Chen Shigong radian evaluation method of western public project management, and combining with the operation logic of "new infrastructure" projects, this paper divides the performance evaluation indicators of "new

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infrastructure" projects into four categories. Based on the characteristics and actual situation of the "new infrastructure" project, this paper designs 23 sub-categories of indicators and 127 specific indicators. The specific index system is shown in Table 1.

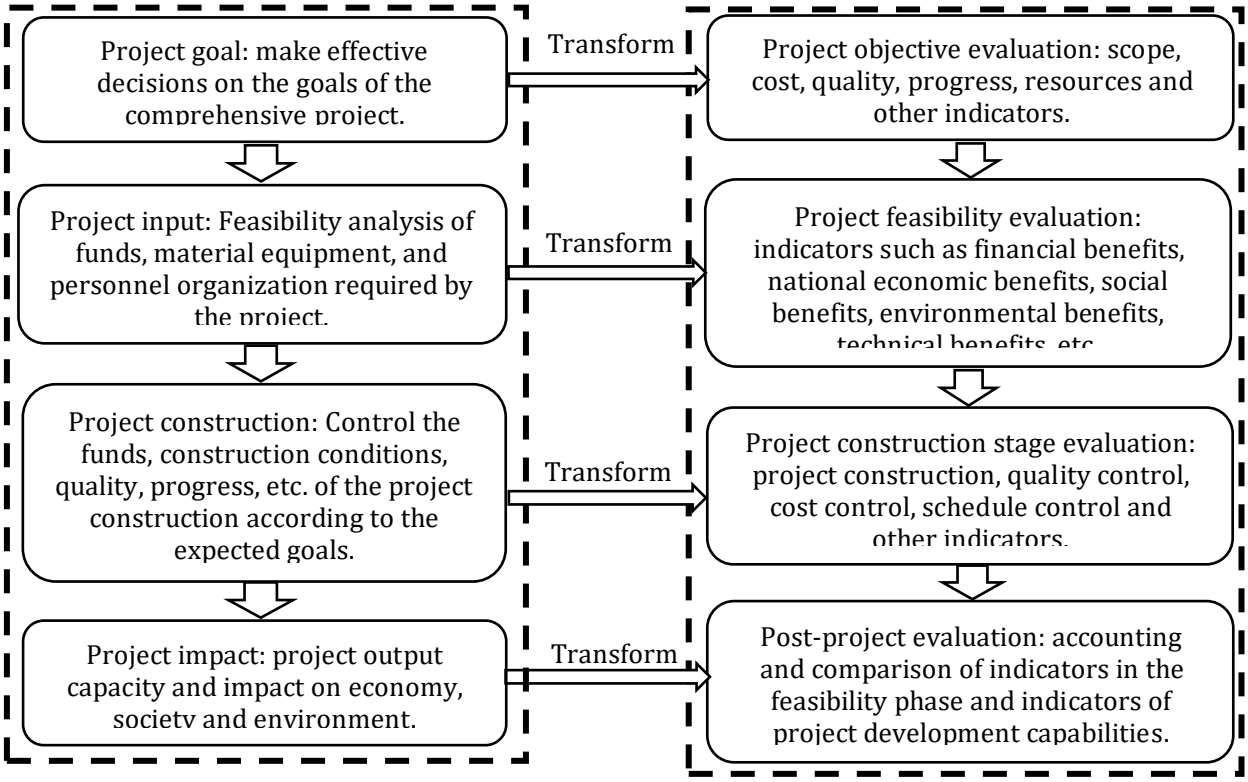

Fig 2. The transformation relationship between project logic and performance evaluation index system

Table 1. "New Infrastructure" Project Performance Evaluation Index System

First Level Indicator	Secondary Indicators	Specific Indicators
Project objective evaluation	1.Scope objectives	Project coverage.
	2.Cost objectives	Total cost of project construction.
	3.Quality objectives	Overall project quality, individual project quality.
	4.Progress targets	Decision-making period, design period, construction period.
	5.Resource targets	Human resources, equipment resources, material resources, service resources.
	6.Benefit objective	Production capacity, years of production, social contribution.
	7.Technical objectives	Technical level, core competitiveness of technology, technological achievements.
Project feasibility evaluation	1.Financial performance evaluation	Net present value, internal rate of return, dynamic investment payback period, investment rate of return, present value of cost, cost-effectiveness ratio, total return on assets, sales profit margin, cost-cost profit margin, capital profit margin, total labor productivity.
	2.Asset operations evaluation	Total assets turnover, current assets turnover, inventory turnover, accounts receivable turnover.
	3.Debt service capacity evaluation	Asset-liability ratio, current ratio, liquidity ratio, cash-flow-liability ratio, tangible net worth-liability ratio.
	4.National economic evaluation	Net present value of economy, internal rate of return of economy, net present value of economic foreign exchange.
	5.Social impact assessment	Total employment effect of unit investment, direct employment effect, indirect employment effect, proportion of

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		national income distribution, proportion of local income distribution, proportion of enterprise income distribution, coefficient of increase of resident income, number of new immigrants, benefits of resettlement, number of new towns, number of new urban population, new electricity bill, new medical fee, unit investment to reduce the number of diseases, amount of new energy supply, amount of new transportation cost.
	6.Environmental impact assessment	Project per capita water consumption, unit investment occupation, new forest land coverage, unit investment damage to cultural relics landscape quantity, unit investment improvement microclimate area, unit investment improvement ecological environment area, unit investment impact animal and plant survival species, new pollution prevention and control costs, exhaust gas emissions, per capita exhaust gas emissions, waste water emissions, per capita waste water emissions, waste water emissions, per capita waste emissions, waste residue emissions, per capita waste residue emissions.
	7.Sustainability evaluation	Income growth rate, per capita income growth rate, profit growth rate, per capita profit growth rate, capital accumulation rate, total asset growth rate.
	8.Science and Technology Benefit Evaluation	Technical contribution rate, technical application, advanced effectiveness of technology, high efficiency of operation and maintenance, ability to provide services.
Project construction phase evaluation	1.Evaluation of funds	Rate of funds in place, rate of own funds.
	2.Project construction	Material consumption quota, material reserve quota, material consumption, construction water consumption, construction electricity consumption.
	3.Quality control	Quality prevention cost, quality appraisal cost, internal loss cost, external loss cost, external quality assurance cost.
	4.Cost control	Planned value (BCWS), earned value (BCWP), actual cost (ACWP), cost performance index, cost deviation, cumulative cost.
	5.Progress control	Duration of work, schedule deviation, current comprehensive schedule deviation rate, cumulative progress deviation rate, delay impact, monthly progress payments, cumulative progress payments, cumulative cash flows.
	6.Analysis of economic effects	Quarterly investment plan completion rate, annual investment plan completion rate, total construction project progress completion rate, construction fund utilization rate, asset delivery utilization rate, construction cost rate, construction cost rate, surplus fund occupancy rate.
	7.Project management evaluation	Qualified rate of engineering quality, excellent and good rate of engineering quality, unit production capacity.
Post-project evaluation	1.Actual project benefit indicators	Accounting of project feasibility phase indicators.
	2.Comparative analysis indicators	Comparison of accounting results and original indicators.
	3.Project development capacity indicators	Level of construction of supporting facilities, level of public recognition, level of policy support, social needs, level of operation and management, project maintainability.

5.1. Project Objective Evaluation

"New infrastructure" projects have a wide range of impacts, and the implementation of infrastructure construction projects will have an impact on regional economic and social development, and may even affect the overall national economy[13]. Therefore, in the early stage of project decision-making, the project goals must be clear and target management must

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be done to ensure the objective and fairness of project decisions. Project target evaluation indicators mainly include scope targets, cost targets, quality targets, schedule targets, resource targets, benefit targets, and technical targets. Among them, the scope target mainly refers to the project coverage area, that is, the radiation scope of the project; the cost target mainly refers to the reasonable range that the total cost of the project construction should be controlled; the quality target includes the overall quality of the project and the quality of a single project; the schedule target includes the decision cycle and the design cycle Etc.; resource targets include human resources, material resources, etc.; benefit targets include production capacity, reaching years, etc.; technical targets include technical standards, technical achievements, etc.

5.2. Project Feasibility Evaluation

"New infrastructure" projects have large investment and long construction period. In the process of project implementation, a large amount of resources such as human, financial and material needs to be invested, and these resources should be managed and used rationally to optimize resource allocation to the greatest extent and pursue the set goals with minimal cost investment. Therefore, the feasibility evaluation and analysis of the project need to be carried out in the early stage of the project, including the evaluation of financial performance, asset operation, debt solvency, national economy, social impact, environmental impact, sustainability and scientific and technological benefits.

Among them, financial performance evaluation indicators mainly include net present value, cost-effectiveness ratio, return on assets, sales profit rate, etc.; asset operation evaluation indicators include asset turnover rate, accounts receivable turnover rate, etc.; The evaluation indexes of solvency include current ratio , quick ratio, asset-liability ratio, etc.; national economic evaluation indicators include economic net present value, internal rate of return, etc.; social impact evaluation indicators include the total employment effect of unit investment, the proportion of national income distribution, residents' income growth coefficient, etc.; natural environment evaluation Indicators include per capita water consumption, investment land occupation, forest land coverage rate, etc.; sustainability evaluation indicators include income growth rate, profit growth rate, etc.; The evaluation indexes of scientific and technological benefits mainly include technology contribution rate and technology application type, etc.[14].

5.3. Evaluation of Project Construction Stage

The implementation of the "new infrastructure" project is a stage in which various participants of the project use specific activities to make full use of the project resources and cooperate with each other to maximize the output of the project. The process control of the project not only helps to ensure the efficiency of the project, but also can adjust the problems found in the project in time. The evaluation of the project construction stage includes capital situation, project construction situation, quality control, cost control, schedule control, economic effect analysis and project management analysis.

Among them, the evaluation indicators of funding status include the rate of fund availability and the rate of self-owned funds; the evaluation indicators of project construction status mainly include material consumption quota, material requirements, construction water and electricity consumption, etc.; quality control evaluation indicators include quality prevention costs, identification costs, Internal and external loss costs, etc.; cost control evaluation indicators include planned value (BCWS), actual costs (ACWP), cumulative costs, etc.; progress evaluation indicators include work duration, cumulative comprehensive progress deviation rate, cumulative project progress payment, etc.; economic effect analysis The evaluation indicators include the completion rate of the investment plan, the completion rate of the total project progress, etc.; the project management evaluation indicators mainly include the project quality qualification rate, unit production capacity, etc.

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5.4. Post-project Evaluation

The post-stage evaluation of "new infrastructure" projects is mainly manifested in the following two aspects: one is the calculation and comparison of indicators in the feasibility stage of the project; the other is the project development capability indicators. The main inspection is the degree of conformity between the results obtained at the completion stage of the project and the early stage target formulation and feasibility plan of the project, which is used to reflect the implementation effect of the project[15].

6. Theoretical Contribution and Practical Inspiration

6.1. Theoretical Contribution

Based on the evaluation index system of traditional infrastructure construction projects, this paper takes "new infrastructure" projects as the evaluation object, and combines the characteristics and actual conditions of "new infrastructure" projects to form 4 major categories of indicators, 23 indicator sub-categories, and 127 indicators Specific indicators, to build a new type of infrastructure construction project performance evaluation index system suitable for the new environment.

The performance evaluation index system of "New Infrastructure" project constructed in this paper is based on the existing research, which further enriches and perfects the project evaluation index system, and provides a new way of thinking for later related research, and also provides theoretical support for the promotion and implementation of "New Infrastructure" project. Compared with the previous performance evaluation index system, the innovation of this paper lies in:

(1) The evaluation index system is more complete. The “new infrastructure” project performance evaluation index system constructed in this paper classifies the relevant indicators of the pre-project, construction and post-phases, and subdivides each category. The overall indicator system is more perfect and the framework is very clear.

(2) The evaluation indicators are more targeted. According to the digital and intelligent characteristics of the "new infrastructure", the project performance evaluation index system adds scientific and technological evaluation indicators, environmental evaluation indicators, and public perception indicators on the basis of traditional infrastructure projects. It is more important on the basis of improving the indicator system. Targeted.

(3) The measurability of evaluation indicators is enhanced. previous measurements of performance evaluation index system did not give specific measurement dimensions. Based on previous research, this article adds specific measurement methods for each indicator, such as the measurement of contrast ratios and indexes, making the indicators more objective. And quantifiable.

(4) Pay more attention to and emphasize the feasibility analysis and evaluation indicators. Performing feasibility analysis in the early stage of the project can effectively evaluate whether the project's operability and profitability and other indicators can achieve the expected goals, and thus judging whether the project is feasible. In addition, the feasibility analysis not only pays attention to economic indicators, but also includes social, environmental, technical and other indicators, so as to evaluate the project more comprehensively. In the post-project phase, the actual situation of the project is evaluated, and the relevant indicators in the feasibility analysis are still used for accounting, which is conducive to discovering the problems in the project through the comparison before and after.

(5) Establish target evaluation indicators in the early stage of the project. Project objectives are the expectation and prospect of project results. The establishment of the goal is the basis of the feasibility evaluation in the early stage of the project, and the key to control in the mid-term

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construction of the project. It is also a comparative reference for the post-project evaluation. This study sets the project goal evaluation indicators to make The project evaluation index system is more complete.

6.2. Practical Inspiration

(1) The performance evaluation index system of "new infrastructure" projects will be widely used in future "new infrastructure" projects. In the “new infrastructure” investment plans successively announced by various provinces and cities, the investment amount is nearly 34 trillion yuan, which is equivalent to one-third of the domestic GDP in 2019. All funds poured into the “new infrastructure”. Relatively speaking, bridge repairs in the eastern region The construction of roads, roads, etc. have been generally completed, and the application of new technologies has been strengthened; the central and western regions have focused more on making up for shortcomings, especially urban rail transit and high-speed railways, but they must also seize the track of “new infrastructure” to avoid being The winner is locked. Speeding up "new infrastructure" has also become an opportunity for the west to catch up with the east. Therefore, the performance evaluation index system will become more perfect, and more scholars will carry out related research.

(2) The research on the performance evaluation index system of "new infrastructure" projects should be more in-depth in the future. The “new infrastructure” creates a modern infrastructure system. This converged infrastructure formed by traditional and new infrastructure will definitely boost the demand for digitalization, and there will be more and more digital investment, which will induce digital With the blowout of infrastructure construction, more and more applications will be generated in this wave, which will undoubtedly cause the support system to become more and more complicated, and the project performance evaluation index system also needs to be deepened and improved according to its development.

(3) Research on the indicator system combining the performance evaluation indicators of "new infrastructure" projects with the PPP model. With the gradual maturity of the PPP model in practice in my country in recent years, PPP mode will be adopted more in "new infrastructure" projects in the future development, which is rooted in the high efficiency of the market. "New infrastructure" is an opportunity to directly invest in the business generated by new technologies. Whether it is industrial Internet, artificial intelligence, cloud computing, Internet of Things, blockchain, etc., it can bring direct benefits. Thanks to the government's support, more and more companies have begun to adopt new technologies to enhance their corporate capabilities in all aspects with government support. Therefore, in future research, more attention needs to be paid to the application of the PPP model in "new infrastructure" projects and its impact on the performance evaluation index system of "new infrastructure" projects.

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