Measurement Mode of Smart Government based on DPSIR Model under the Background of Smart City

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Abstract: Data-driven and technology empowerment have become the key to the innovation of government affairs in the information age, but government affairs are not fully mature, and there is a lack of a scientific rating system for dynamic monitoring and feedback. This paper evaluates smart government construction as the research subject and combines the DPSIR model and sustainable development theory to build an indicator system for smart government. At the same time, the analytic hierarchy process (AHP) is used to allocate the weight of the indicator system, and then optimize the system through the Delphi method. Based on the integration of interdisciplinary theories, it is of great significance to explore the measurement mode of smart government construction in the new period, realize the real-time evaluation of smart government construction, and effectively improve the efficiency of government governance and public service, which can help improve government management and services in China.

1 INTRODUCTION

Since IBM (International Business Machines Corporation) put forward the vision of building Smart City in 2008, the concept of "Smart" appeared in public. Smart government, an indispensable part of constructing smart cities, is the brain and nervous system of the whole smart city (Guo, 2016, Liu, 2016, Yu, 2016, Hu, 2016, Sang, 2016), and there is no lack of research and discussions on smart government in academia. "Smart government", analyzed from morphemes, can be divided into two parts - "smart" and "government affairs." "Government affairs" is the working form of its vertical development, and "smart government" is the way to build a government that can use information and communication technologies to solve essential problems better (Mellouli, 2014, Luna-Reyes, 2014, Zhang, 2014). "Smart" is a high-level model of its horizontal development, and smart government has been envisioned as an adaptive evolution of government in academia. Unlike previous government work, Smart Government can integrate existing new-generation information technologies such as cloud computing, big data and artificial intelligence (AI) to integrate various management departments and management modules. It can reduce the possibility of "Business Process Silos" by establishing effective internal business collaboration, while reducing the "Data Divide" and improving the efficiency and quality of government services by building a highly interconnected working mechanism and service platform (Kankanhalli, 2019, Charalabidis, 2019, Mellouli, 2019).

Although the overall construction of smart government in China has achieved initial success, there are still some problems, such as lack of government planning, incomplete organizational structure, low coordination efficiency, low social participation. The effect of comprehensive construction needs to be further improved. Building a perfect evaluation indicator system can provide value orientation for smart government. However, the current evaluation indicator system mainly focuses on the breakthrough of smart government in technology and government performance. Less consideration is given to the influence of social and environmental benefits on performance evaluation. The smart government evaluation system based on sustainable development has a big system view of evaluation, which will lay a good foundation for the construction of smart government.

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2 APPLICATION OF THE DPSIR MODEL FROM THE PERSPECTIVE OF SUSTAINABLE DEVELOPMENT

2.1 Explanation of the DPSIR Model and Sustainable Development

The Brundtland Commission released Our Common Future in 1987, also known as the Brundtland Report, which put forward “sustainable development” for the first time and won international recognition. It was defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Castro, 2021, Lopes, 2021). Based on previous academic views, we summarize and foster new meanings to sustainable development - common, coordinated, fair, efficient, and people-oriented.

The DPSIR model comprises five rating indicators, including driving forces, pressures, states, impacts, and responses, constituting a natural system evaluation indicator system (Zhao, 2021, Fang, 2021, Liu, 2021, Liu, 2021). Each type plays a different role in the system, respectively, and there exists both a distinction and a correlation between the five elements and an established logical relationship, while the five types are divided into several categories of indicators.

2.2 Applicability Analysis of DPSIR

From the perspective of sustainable development, the construction of smart government can be regarded as an organic system of smart government composed of multiple subsystems. DPSIR can be applied to systematic evaluation, and the effect evaluation of smart government construction can be carried out from the perspective of a large-scale system. First, the relationship between the elements of DPSIR can dynamically show the effectiveness of each part, instead of describing the research object statically and in isolation. It emphasizes the influence of human factors on the environment and the environment’s response to the system (Ruan, 2019, Li, 2019, Zhang, 2019, Liu, 2019). Secondly, DPSIR can deal with some qualitative information, which is convenient for selecting a more suitable mathematical method for calculation and getting more operable and dominant results. Finally, the theoretical framework of DPSIR model theory can provide an excellent theoretical basis for the construction of smart government evaluation system, and has strong applicability. Therefore, DPSIR is selected as the supporting theory of the evaluation system in this paper.

3 DIMENSION CONSTRUCTION: A MEASURING TOOL FOR THE EFFECT IN SMART GOVERNMENT CONSTRUCTION

3.1 The Significance and Role of Dimension in Evaluation System Construction

Dimension is a coordinate for understanding the whole thing and a thinking method for analyzing things. The evaluation of the effect of smart government construction needs corresponding indicators to measure. Scattered and messy indicators cannot support evaluation work. By classifying the corresponding indicators and dividing them into different dimensions, we build an effective indicator evaluation system, find the relationship between evaluation objects, and thus carry out scientific and reasonable evaluation (Wang, 2020) Based on orderly integration of the value goal and content orientation of the effect evaluation of smart government construction, dimension analysis can more objectively reflect the connotation of smart government construction effect evaluation, enhance the logicality, directivity and accuracy of indicator system selection, and scientifically construct the indicator of smart government construction effect evaluation.

3.2 The Establishment and Interpretation of the Evaluation Dimension of Smart Government

This paper analyzes the construction of smart government from five dimensions of DPSIR, which can reflect the causal relationship between dimensions and the feedback principle contained. Human factors have become “driving forces” to promote system change, thereby giving birth to “pressure” that affects the development direction of the system. Under pressure, the smart government system presents a corresponding “state”, and under the comprehensive action of the first three indicators, the smart government construction has an “impact”.

Finally, the actors of smart government construction formulate relevant laws, policies or plans as “responses” for “driving forces”, “pressures”, “states” and “impacts”. These five indicators comprehensively reflect the comprehensive effect of smart government construction, and are five dimensions of establishing an evaluation indicator system.

Driving forces reflect the main factors that promote the system when environmental and social factors act on it for a long time.

Pressures evaluate the state and ability of the government to cope with risks and challenges in its work, focusing on the technology and system of promoting the construction of smart government.

States are the performance of smart government under the combined action of driving forces and pressures, aiming to highlight the research object’s most essential characteristics.

Impacts are evaluated based on the promotion of smart government to the whole government work in the exploration process and the effectiveness of improvement.

Responses refer to measures taken by various actors in response to the evaluation of the smart government construction to promote a more adapted and better functioning of smart government in the current situation.

4 INDICATOR SYSTEM: A TOOL FOR MEASURING THE EFFECT OF SMART GOVERNMENT CONSTRUCTION

From the perspective of DPSIR, the construction effect of smart government is comprehensively considered from five indicators. In essence, based on the theory of sustainable development, the evaluation connotation of sustainable construction is transferred to smart government construction, an innovative attempt in the interdisciplinary evaluation and mutual learning. We standardize and guide the construction of indicator systems under the guidance of the evaluation connotation of sustainable circular development. In terms of operability, the formulation of indicators focuses on application; Therefore, based on completing the construction of the indicator system and assigning weights to it, this paper uses the review of existing literature and visits to surveys to give a careful consideration of various factors affecting the application of indicators, to give a more systematic indicator evaluation model and reference to the use of indicators, and to provide an idea for the application of indicators by evaluation subjects.

4.1 The Construction and Optimization of the Indicator System

4.1.1 Preliminary Construction of Evaluation Indicator System

The goal of this paper is to evaluate the effect of smart government construction. Constructing the corresponding indicator evaluation system is the basis of construction effect evaluation. This paper grasps the research status of smart government through literature collection, grasps the primary evaluation methods, and constructs the evaluation indicator system to carry out a continuous longitudinal dynamic evaluation. According to DPSIR, the evaluation system of smart government construction is divided into five dimensions: driving forces, pressures, states, impacts and responses. A preliminary evaluation indicator system is obtained according to the above-mentioned structure and authoritative literature work (see Table 1). The system includes five first-class indicators, 11 second-class indicators, 29 third-class indicators and several main observation points corresponding to them.

Table 1: Preliminary smart government evaluation system.

First-class indicator	Second-class indicator	Third-class indicator
Driving forces	Economic drives	Growth in fiscal revenues
		Proportion of special funds to fiscal expenditure
		Fund management and expenditure status
	Technology-driven	Intensity of investment in R&D
		ICT patent and conversion rate of scientific and technological achievements
Pressures	Data information	Data information security
		Data information sharing
	Compatibility	Compatibility of information system
		Acceptance of staff on the new mode

		Overall management ability of leaders
States	Communication Support Foundation	Construction of network infrastructure
		Technology for platform operation and maintenance management system
	Platform for internal collaboration	Development of efficient office system
		Development of intelligent decision system
		Development of automatic supervision system
	Public service platform	Degree of information disclosure
		Usage of platform
Impacts	Efficient government work	Convenient mobile office
		Concise working procedures
		Precise prediction and decision
		Real-time discrimination of monitoring mechanism
	Interaction of social services	Personalization of government services
		Satisfaction with complaint resolution
		Visualization of data analysis
Responses	Responses to policy adjustment	Frequency of policy introduction
		Authority of policies
		Degree of policy implementation
	Responses to talent cultivation	Training system for technical professionals
		Feedback on staff training

Some observation points of indicators: 1. Intensity of the investment in research and development (R&D): equivalent to economic support, which is a powerful guarantee for improving innovation from scientific research (scientific research funding support); 2. ICT patents and the rate of technology transfer: the proportion of scientific and technological achievements successfully applied in information and communication technology patents to the total number of scientific research achievements in the statistical cycle (original support); 3. Pressure from data information security: information laws and regulations, data confidentiality norms, data leakage penalties and data storage forms.

4.1.2 Optimization of the Evaluation Indicator System

In this paper, when optimizing the evaluation system of the effectiveness of smart government, we compare various methods of screening indicators. Finally, we decided to use the Delphi method to screen them, using anonymous feedback. After extensive consultation with experts, after collating, summarizing and counting, we again conduct centralized feedback so that the indicators can reach a relatively optimal state while the opinions gradually converge (Pr 2021, Bbtdc 2021, Ga 2021, Nm 2021). When using the Delphi method of testing, the number of expert groups is generally not less than 10. In order to avoid the influence of subjectivity, this paper selected ten people working in government agencies and those who have expertise in e-government to issue expert questionnaires. Ten copies were returned in both rounds of the screening process, and the positive coefficient of experts was 100%.

4.1.2.1 Screening Indicators by the Delphi Method in the First Round

Firstly, the importance of the first edition of Rickett's five-point scale is measured, that is, one is very unimportant, two is not important, three is average, four is important, and five is very important. The maximum value of each indicator is max and the minimum value is min, and then the mean value C, standard deviation s and dispersion coefficient C.V of each indicator are calculated respectively. When $0.1 \leqslant C.V \leqslant 0.2$, the importance of the indicator meets the requirements.

According to the expert consultation, we can see that most indicators in the preliminary indicator evaluation system meet the requirements, which shows that the system tends to be good. There are 12 problematic indicators, of which the amount of revenue growth, the proportion of special funding to financial expenditure, staff acceptance of the new mode, the usage of platform, communication technology support, efficiency of government work, and satisfaction with complaint resolution need to be adjusted, while the authority of policies, the state of funding management and expenditure, the ability of leaders to co-ordinate and manage, the visualization of data analysis and the real-time discrimination of monitoring mechanisms need to be deleted.

The advice given by experts is that the evaluation indicator system should have a strong correlation when choosing indicators to prevent generalization. The monitoring mechanism and response mechanism need to be constantly adjusted and improved according to the smart government's actual situation and specific content. The usage of the platform is relatively general, which should be decomposed into two indicators. And it is more appropriate to evaluate the coverage of the platform and the usage habits of platform users. The study draws on expert opinion to adjust the indicator system accordingly, and conducts a second round of indicator screening again.

4.1.2.2 Screening Indicators by Expert Judgment in the Second Round

The steps and methodology of the second round are the same as those of the first round. The revised indicator system has won the consensus of experts.

4.1.2.3 Inspection of Coordination Degree of Expert Opinions

Kendall's W synergy coefficient will be used to calculate the consistency test of expert opinions. When the same evaluator has the same rating, the calculation formula of W is as follows:

$$W = \frac{S}{\frac{1}{12}K^2(N^3-N)-K\sum_{i=1}^{K}T_i} \quad (1)$$

$$T_i = \sum_{j=1}^{m_i}(n_{ij}^3 - n_{ij})/12 \quad (2)$$

N refers to the number of indicators to be evaluated, and K represents the number of people who scored;

S is the sumR_iof squares of the deviation and the sum of the grades evaluated by an evaluated object and the average of all these sums;

Here, m_i is the number of their repeated grades in the evaluation result, and n_ij is the number of the same levels of the evaluator. When W is between 0 and 1, and the closer it is to 1, the higher the consistency of expert opinion and the more reasonable the evaluation results, and vice versa. The synergy coefficient of expert opinions of the two rounds W is calculated by SPSS, as shown in Table 2.

Table 2: Calculation results of the test in coordination.

	W-value
Round-1 Scoring	0.152
Round-2 Scoring	0.381

According to Table 4, the synergy coefficient of the first round in Round-1 Scoring is 0.152, and Round-2 Scoring is 0.381, indicating that the coordination between expert opinions increases. In addition, the significance value P of the two rounds of synergy coefficient is far less than0.05, which shows that the synergy coefficient is significant. That is, the evaluation results are consistent.

4.2 The Calculation and Allocation of Indicator Weights

The allocation of indicator weights is an essential link in building the evaluation indicator system of the effect of smart government construction, which has a great impact on the evaluation quality of the indicator system. Therefore, the allocation methods of indicator weights need to be compared repeatedly and carefully selected to make the final allocation of indicator weights objective, accurate, scientific and reasonable. Calculating indicator weight can be summarized into the following four types: 1. Information enrichment method, mainly represented by factor analysis and principal component analysis; 2. Digital relative size analysis method, mainly represented by AHP hierarchy method and pecking order diagram method; 3. Using the amount of information, that is, the amount of information carried by data, mainly taking entropy method as an example; 4. Analyze data volatility or correlation, mainly taking CRITIC, independence and information weight as examples.

Each of the above methods has its characteristics and advantages. Through practical application analysis, this indicator system's indicator weight allocation method is mainly AHP hierarchical method. Thomas L. Saaty developed this decision-making method. It combines qualitative and quantitative methods to analyze complex analysis objectives hierarchically, making subjective evaluation objective and simplifying complex problems. AHP can make the problem organized and hierarchical, make each indicator easy to analyze quantitatively, carry out the simple sorting calculation, effectively determine the weight of each evaluation indicator, and obtain more accurate results.

Through the research and analysis of AHP, according to the principle and calculation method of

AHP, the following indicator weight allocation steps are carried out:

First, design a questionnaire for experts for the evaluation indicator system of smart government construction effect, which includes the first-level, second-level, and third-level indicators, and compare the importance of influencing factors in pairs at the same level.

Second, invite relevant experts to fill out the questionnaire and recycle it after filling it out. A total of 10 questionnaires were distributed and ten were recovered, with an effective rate of 100%. After recovery, integrate and summarize the survey data of the questionnaire, and prepare for the next analysis.

Thirdly, using "yaahp" to calculate the indicator weight, firstly, the single hierarchical ranking is carried out, that is, for a particular factor in the previous layer, the ranking of the importance of each factor in this level. There is the general hierarchical ranking, the ranking from the highest level to the lowest level in turn, and the ranking weight process of determining the relative importance of all factors in a certain level to the general goal. After the calculation, the indicator weight is analyzed by consistency test to judge whether it conforms to logical consistency, and the inconsistent indicator data is screened and adjusted to get the specific data of the final indicator weight.

Table 3: Weight allocation of smart government evaluation indicator system.

First-grade indicator	**Second-grade indicator**	**Third-grade indicator**
Driving forces 0.2111	Economic Drives 0.1156	Growth of fiscal revenue 0.0422
		Special funds for smart government account for 0.0734% of fiscal expenditure
	Technology Drives 0.0955	Input intensity of research and development (R&D) 0.0394
		The rate of technology transfer and ICT patents 0.0566
Pressures 0.11435	Data information pressure 0.06775	Data information security pressure 0.04316
		Data information sharing pressure 0.02459
	Compatible pressure 0.0466	Compatibility of Information system 0.0311
		User acceptance of the new mode 0.0155
States 0.2734	Construction of basic support 0.06625	Construction of network infrastructure 0.03934
		Technology for platform operation and maintenance management system 0.02316
	Platform for internal collaboration 0.12365	Development of efficient office system 0.05734
		Development of Intelligent Decision System 0.04124
		Development of Automatic supervision system 0.02507
	Public Service Platform 0.0835	Information publicity 0.03967
		Scope of Platform promotion 0.0217
		Depth of platform application 0.02213
Impacts 0.19095	Smart Government 0.12174	Convenient mobile office 0.0563
		Concise working procedure 0.04156
		Accurate forecast and decision-making 0.02388
	Interactive social services 0.06921	Personalization of government services 0.04135
		Satisfaction of appeal resolution 0.02786
Responses 0.21025	Responses to policy adjustment 0.07851	Frequency of policy introduction 0.04722
		Degree of Policy implementation 0.03129
	Talent training response 0.13174	Technical professionals training system 0.04392
		Staff training feedback adjustment 0.0878

Some indicator observation points: 1. Research and development (R & D) investment intensity: equivalent to scientific research economic support, refers to the ratio of R&D investment to GDP and is a powerful guarantee for improving scientific research innovation strength (scientific research funding support); 2. ICT patents and conversion rate of scientific and technological achievements: the proportion of scientific and technological achievements successfully applied in information and communication technology patents to the total number of scientific research achievements in the statistical cycle (original support); 3. Data information security pressure: information laws and regulations, data confidentiality norms, data leakage penalties and data storage forms.

4.3 Model of the Indicator System and Its Use

Finally, after screening, optimization and weight allocation, the evaluation system of smart government construction effect gets five first-level indicators, 11 second-level indicators and 25 third-level indicators. Furthermore, all levels of indicators are qualitative indicators in the evaluation indicator system constructed in this paper, which can be measured by qualitative methods, with high operability and high data availability. As a new work direction, smart government often lacks experts who can accurately grasp the specific contents and objectives of smart government construction, which cannot ensure that the selected experts can carry out credible sample extraction and evaluation, so it is not feasible to adopt expert bid evaluation method. Compared with the previous method, the questionnaire survey method is more operable, and the results are relatively scientific and credible. In the practical application of the indicator system, the research group adopts the method of questionnaire survey, taking the staff of government agencies as the sampling objects, scientifically and reasonably determining the sampling number and obtaining data, which is convenient for the subsequent calculation, processing and analysis of the obtained data.

The evaluation of the effect of smart government construction needs to use an evaluation method that can describe the whole system of the evaluation object and analyze the complex representations of the evaluation object hierarchically. The multi-indicator comprehensive evaluation method is an evaluation system that uses a specific model and evaluates the research object based on the existing indicator system. The fuzzy comprehensive evaluation method is one of the commonly used methods of comprehensive evaluation method. Fuzzy mathematics is used to comprehensively consider various factors affecting the evaluation of smart government construction, and membership function relationship is used to describe the fuzzy boundaries among various factors (Zhou 2021, Cai 2021, Xu 2021, Wang 2021, Jiang 2021, Zhang 2021). Although there is no lack of traditional comprehensive evaluation method in indicator evaluation, it is more appropriate to adopt fuzzy comprehensive evaluation method because of the complexity of intelligent government construction factors and the fuzziness of evaluation influencing factors and the objective conditions that the indicators provided in this paper have many qualitative indicators.

The specific application steps of the indicator calculation method are as follows:

1) Determine the factor set to judge the effect of smart government construction.

2) According to the needs of evaluation, the evaluation set is given. According to the evaluation demand of smart government construction effect, according to Likert's five-point scale, the general evaluation set includes five evaluation elements: very significant, relatively significant, significant, not significant and highly insignificant.

3) List the membership function relationship. Statistics and analysis of the questionnaire data, determine the functional relationship between each evaluation value and evaluation factor value, and form a comprehensive evaluation fuzzy relationship matrix.

4) Determine the weight set of evaluation factors. The weights of the indicators determined in the previous article can be directly taken as the weights of the evaluation factors, and the weights of all the evaluation factors constitute the weight set of the evaluation factors.

5) Solve the fuzzy comprehensive evaluation matrix. Using the membership function relationship and the weight set of evaluation factors, the fuzzy synthesis operation uses the primary factor determination type.

6) By normalizing the fuzzy comprehensive evaluation set, the final membership set is obtained.

7) Determine the final comment according to the principle of maximum membership degree.

By using fuzzy comprehensive evaluation method to process the data obtained from the questionnaire, understand their subjective feelings according to the scores of the five-point scale, synthesize the weight assignment of each indicator, and finally get the comment with the maximum membership degree after calculation, which is the actual application process of the evaluation indicator system of smart government construction effect.

5 CONCLUSION

This paper tries to establish the effect evaluation system and scientific empowerment of intelligent government affairs construction, In the next step of research, it is necessary to conduct an empirical study on the indicator system, transform the "theoretical" indicator into the "practical" indicator, and select the pilot area to evaluate the effect of smart government construction based on controllable research scope and available data. Evaluate the current process of smart government construction more accurately, and continue to follow up to achieve dynamic monitoring; In further research, according to practical feedback and empirical analysis, scientific theories and algorithms can be used to form the target value of staged evaluation indicators, accurately draw the baseline of indicators, and better realize the measurement of the construction effect of smart government affairs.

Under the brand-new information age background, the smart government platform plays a ubiquitous role and is the core node of the whole government network. The government reconstructs the business flow through informationization and promotes the "connectivity" of data (Lv, 2018, Li, 2018, Wang, 2018, Zhang, 2018, Hu, 2018, Feng, 2018). Promoting smart government cannot be separated from monitoring and evaluating its construction effect. Open up an evaluation system for the construction effect of smart government affairs from the new perspectives of "sustainable development" and "smart ecology", Accord to that analysis logic of "driving-force-pressure-state-influence-response", Multi-dimensional and timely monitoring of the construction process of smart government affairs, Guided by the evaluation results, dynamically adjusting the platform construction is not only conducive to expanding the monitoring and evaluation path in the field of smart government affairs, but also conducive to grasping the big engine of data empowerment, to comprehensively improve the government affairs management and service level of our government, improve the government affairs efficiency, and promote the modernization of the national governance system and governance capacity.

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