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Study on the Guiding Effect of Chinese Smart City Construction to Ecological Environment Based on Structural Equation Modeling

Li Chen[1,*], Ying Xu[2], Chenxuan Wang[3], Anan Zhang[1]
[1]School of economics and management, Anhui Jianzhu University, Hefei, Anhui, China
[2]Anhui University of Science and Technology, Huainan, Anhui, China
[3]School of Economics and Management, Anhui Agricultural University, Hefei, Anhui, China
*Corresponding Author.

Abstract:

The sudden outbreak of the novel pneumonia was a major test of the city's emergency ability. Information technology played an important role in the process of epidemic prevention and control and the resumption of work and production. With the support of information technology, the city ushered in the transformation of its development model. Building a new type of smart city has become one of the effective measures to deal with the epidemic, which is the focus of future urban development. In order to meet the needs of urban construction, this paper focuses on the main factors affecting smart city construction, in order to facilitate the construction of new smart city. Through the literature reading to summarize both at home and abroad, on the basis of qualitative analysis of wisdom city construction, determine the government support, technical support, the ecological environment, infrastructure, as the focus of the wisdom urban construction, according to the questionnaire data collected data using structural equation model, government support, technical support, the interaction between ecological environment and infrastructure, And quantitative interpretation of their respective impact on the level of smart city construction. The research results show that smart city construction is influenced by many factors, among which government support plays the most important role, followed by technical support, and ecological environment and infrastructure construction are also important factors. We should take technological innovation as the breakthrough point to promote the transformation of growth pattern; Pay attention to the excavation of urban characteristics, improve the level of urban publicity; Through information resource sharing, improve the comprehensive management level; Starting from the development of intelligent applications, improve the level of urban informatization.

Keywords: *Smart city, Structural equation, Government support, Technical support, Humanities foundation, Infrastructure.*

I. INTRODUCTION

With the development of society and the continuous progress of human beings, cities will bear more and more people. At present, there are many problems and challenges to be solved in the development of

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cities: environmental pollution; limited education and medical security; imperfect infrastructure; economic structure to be changed, etc. In order to combat the increasingly complex "urban disease" and realize the city's green, livable and efficient development, the construction of smart city has become an irresistible historical trend of the world's development. The concept of smart city originated from the strategy of "smart earth" put forward by IBM in 2008, and is considered as a new direction of future urban development [1]. It is based on artificial intelligence, Internet of things, big data, cloud computing and other information technologies [2]. Through sensing, analyzing and processing all kinds of important information in the process of urban operation, it makes intelligent response to the needs of transportation, public security, medical treatment, environmental protection, business activities and other aspects, improves the comprehensive value and overall operation efficiency of the city, and creates comfort for residents. A comfortable, high quality life. The starting point of smart city is the network and digitization under the development of modern information technology, and the ultimate goal is to raise it to the height of integration, cluster and collaborative management, and build a livable urban environment. The practical significance of smart city for social development is mainly reflected in three aspects: first, to promote the optimization of urban spatial structure. The agglomeration of population and industry caused by urban development has brought challenges to urban transportation, medical treatment and environment. The application of new generation information technology can alleviate "urban disease" and make urban layout more flexible in space. Second, optimize environmental quality. Based on some emerging technology industries such as big data, AI and Internet of things, smart city has the characteristics of low energy consumption, strong collaborative operation ability and high product added value compared with traditional industries, which can effectively reduce the resource consumption brought by economic development. Third, create new driving forces for economic growth [3]. Smart city is a city of sustainable development, which needs strong economic and social forces to lead. Smart city integrates the latest generation of high-tech, which will promote the continuous prosperity and development of the existing information industry, spawn and nurture new industries, and find new economic growth points.

Green and sustainable is the development direction of smart city, and also the core and basic destination of urban construction. Ecological civilization and smart city complement and promote each other. With people's yearning for a better life, people's demand for a living city is not only a single economic consideration, but also some factors related to spiritual enjoyment, such as convenient transportation, efficient government services, livable environment, etc [4]. Under the traditional economic growth mode, resources are exploited predator, and the ecological environment is seriously damaged, which leads to a series of urban diseases such as environmental pollution. The development of smart city needs to realize green transformation, and green technology helps to improve the efficiency of resource utilization and the ability of environmental governance. While promoting economic growth, it can maintain a good ecological environment, realize win-win development and protection, and meet the public's expectation for future urban development. Therefore, the construction of smart city should be guided by green technology, highlighting the core pursuit of green environment. Encourage the development of resource conservation and environment-friendly industries, restrain the expansion of high pollution and high energy consumption industries, and achieve the integration of technology and environment, so as to improve residents' sense of happiness, experience and gain.

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II. MATERIALS AND METHODS

2.1 Model Selection and Hypothesis

Qian Xuesen, in the theoretical article "technology of organization and management: System Engineering" jointly published with Xu Guozhi and Wang Shouyun, summarized the city as a complex system with human as the main body and intensive population, technology, economy and culture. On the basis of original city function, smart city integrates information technology and works with other resources integration and optimization to form a complex system with "smart" characteristics. Anthony Townsend (2015), an American author, describes the future of the city from a prospective perspective in the book smart city: with the popularization of mobile devices, it will combine with infrastructure, daily goods, etc. to solve the problems of people's livelihood, transportation, environment, etc. According to Nam (2011), smart city is composed of technology, people and institutions, and technology is the core of smart city [5]. Nicos komninos (2006) proposed that people are the basic aspect of the indicator system of smart city, because it is the gathering of people that forms the city [6]. In addition, because people cooperate and innovate with each other, they can realize the connection between people and cities in the practical sense, which are also the parts involved in the indicator system of smart city. Xu Qingrui (2012) and others believed that smart city is a city with the goal of satisfying residents' sense of security and happiness in life and realizing the comprehensive and sustainable development of "economy society ecology"[7]. Zhao Gang (2012) proposed that smart city should be a city convenient for residents' life on the basis of intelligent operation [8]. Due to different research focuses on Smart City, scholars at home and abroad have different interpretations on the concept of smart city, but most of them think that smart city should have the following three characteristics: first, the operation and management of smart city is supported by smart technology; second, smart city is a complex system that requires the collaborative participation of all parties; third, the construction of smart city. The starting point is human, and the final destination is human. Its purpose is to make urban residents have more sense of gain and happiness.

For the research of smart city construction, the current research methods are: Delphi method, factor analysis method, gray correlation method, AHP and so on. Cao Yang and Zhen Feng build a smart city evaluation model by monitoring and evaluating the operation and development status of the city, optimizing the spatial layout and resource allocation, and providing intelligent urban spatial planning methods [9]. Zhao Meng and others take the evaluation of the benefits of smart city as the research object, and construct the evaluation index system of the benefits of smart city based on the subjective feelings of citizens. Zou Kai and Bao Minglin put forward the evaluation system of the development potential of smart city based on the grey relation and BP neural network algorithm, in order to analyze the problems of inadequate recognition of smart city and insufficient evaluation of development potential in China [10]. Wang Zhenyuan and Duan Yongjia used the analytic hierarchy process to construct a set of evaluation index system for the development of smart cities in China by considering the factors of urban public system, infrastructure level and smart application level [11].

Structural equation modeling is also known as co-variance structural model, which is composed of

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structural model equation and measurement model equation. It is a model that can establish, estimate and test causality. Structural equation can not only analyze the measurement error, but also analyze the relationship between potential variables, and estimate the fitting degree of the whole model. Based on the understanding of the advantages of structural equation, this paper decided to adopt this method to reveal the influence of government support, technology support, human foundation and infrastructure construction on the construction of human based smart city by establishing the structural equation of the construction level of smart city [12].

Equation of structural mode: $$\eta = \mathrm{B}\eta + \Gamma\xi + \zeta \quad (1)$$

Equation of measurement mode: $$X = \mathrm{A}_x\xi + \sigma \quad (2)$$

$$Y = \mathrm{A}_y\eta + \varepsilon \quad (3)$$

Among them, η is the matrix of endogenous potential variable (potential dependent variable), ξ is the matrix of exogenous potential variable (potential independent variable), β is the matrix of structural coefficient, which represents the interaction between the constituent factors of η in the structural model, γ is the matrix of structural coefficient, which represents the interaction between the constituent factors of ξ in the structural model, X and y are the matrix of measurement variables of ξ and η respectively, α is the matrix of measurement variables. Coefficient matrix, ζ is structural equation residual matrix, δ and ε are measurement equation residual matrix.

According to the relevant theoretical research basis and the actual situation of the research area, this paper considers that there are 10 hypothetical paths for the measurement model of influencing factors of the construction level of smart city (see Figure 1). The specific assumptions are as follows:

H1: government support has path impact on technical support.

H2: Government support has path impact on ecological environment.

H3: government support has path impact on infrastructure.

H4: technical support has path impact on the construction level of smart city.

H5: technical support has path impact on infrastructure.

H6: infrastructure has path impact on the construction level of smart city.

H7: Ecological environment has path impact on technical support.

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H8: The ecological environment has a path impact on the construction level of smart city.

H9: the construction level of smart city has a path impact on people's livability and industry.

H10: the construction level of smart city has no path impact on people's sense of existence.

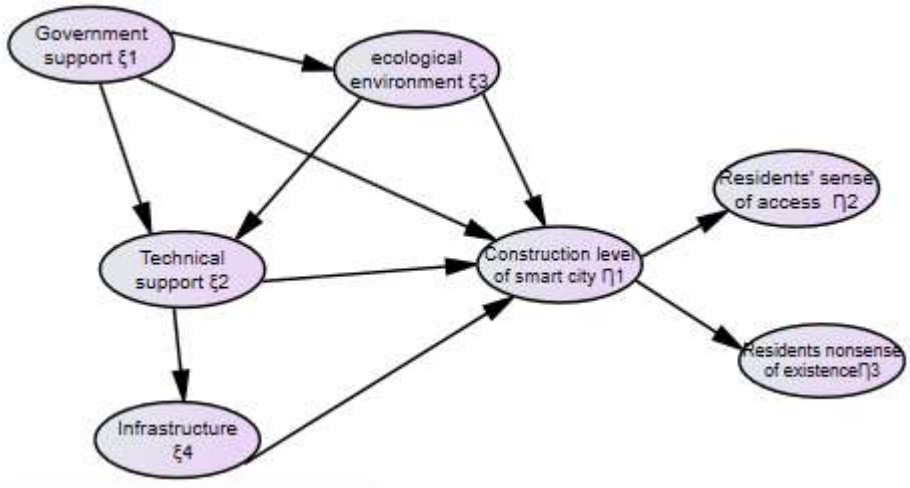

Fig 1: hypothesis of influencing factors of smart city construction

2.2 Materials

Source and Treatment of indicators as follows.

This paper refers to the research results of relevant literature, combined with field research and specific development, through the way of questionnaire to collect relevant data. The design of the questionnaire focuses on the intelligent needs and experience of citizens in the process of building a humanistic smart city. The questionnaire includes 7 potential variables and 21 measurement variables. Likert's 5-component method was used in the design of the questionnaire. The questionnaire is distributed online and offline, and 109 valid samples are collected. This paper analyzes this part of data. The specific design of the questionnaire is shown in Table I.

TABLE I: Questionnaire design

Latent variable	Observed variable	Problem description
Government support ξ_1	Promotion of smart city X_1	How do you feel about the function promotion of smart city
	Urban development planning X_2	How do you feel about the development plan of the city in the next ten years
	Industrial management policy X_3	Do you think the information industry can promote the sustainable development of the city and the ability of coordination among various departments

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	Strength of intelligent application development X_4	How do you feel about the collaborative service and information disclosure of E-government
Technical support ξ_2	Wireless network X_5	What do you feel about the network transmission speed of your current residence or work (Study) place
	Internet of things X_6	You feel that face recognition, voice recognition, fingerprint recognition and other technologies of Internet of things terminals
	Cloud computing X_7	Do you think online office and personal online disk are safe and confidential?
	Big data X_8	In terms of urban service and personal life, you think the ability and speed of data storage, backup, recovery and analysis
ecological environment ξ_3	Environmental quality monitoring x9	Your understanding of automatic monitoring of environmental quality
	Pollution source monitoring X_{10}	Your understanding of key pollution source monitoring
	New energy efficiency X_{11}	How well do you know about the use of new energy
	Green building x_{12}	How well do you know about green buildings
Infrastructure ξ_4	transportation X_{13}	How do you feel about the monitoring of ecological environment by GIS, UAV, etc.
	Public safety X_{14}	How do you feel about the construction of video monitoring system in dealing with social security, natural disasters and accidents?
	Medical treatment, education X_{15}	What do you feel about intelligent development, such as online registration, online learning and understanding of traffic conditions
Construction level of smart city η_1	Development situation y_1	Compared with the previous years, you feel that the development of urban informatization level
	Holistic perception y_2	How do you feel about promoting a highly integrated and intelligent city
Residents' sense of access η_2	Livable y_3	How do you feel about the city's civilization, management and appearance
	employment y_4	How do you feel about the employment environment in the city of "building a nest to attract Phoenix"
Residents nonsense of existence η_3	Few jobs y_5	Will you continue to work in this city
	Management confusion y_6	Do you think the problem of city management is serious

2.3 Methods

2.3.1 Reliability analysis

Reliability analysis, also known as reliability analysis, reflects the true degree of the tested indicators. Because there are no repeated measurements in this case, we mainly use indicators reflecting internal consistency to measure the reliability of data. The commonly used detection method is Cronbach's alpha

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coefficient, which is the first choice to evaluate the internal consistency. When the value of Cronbach's alpha coefficient is greater than 0.7, it means high reliability; when the value of Cronbach's alpha coefficient is between 0.35 and 0.7, it means general reliability; when the value of Cronbach's alpha coefficient is less than 0.35, it means low reliability.

In this paper, SPSS software is used to test the consistency of index data, which shows that Cronbach's alpha coefficient is 0.802, indicating that the data used in the case has good reliability (see Table II).

TABLE II. Reliability analysis results

Cronbach's alpha	Item number
.802	21

In addition, the reliability test results of each potential variable in the questionnaire are shown in Table III. The reliability test results of each potential variable show that, except for the indicator of "residents have no sense of acquisition", the value of λ is above 0.7, which indicates that the potential variables in the sample contain higher consistency. See Table III for inspection results.

TABLE III. Reliability test of potential variables

Latent variable	cronbach's alpha	Item number
Government support ξ_1	.852	4
Technical support ξ_2	.811	4
ecological environment ξ_3	.843	4
Infrastructure ξ_4	.829	3
Construction level of smart city η_1	.925	2
Residents' sense of access η_2	.727	2
Residents nonsense of existenceη_3	.255	2

2.3.2 Validity analysis and exploratory factor analysis

Using SPSS to do kmo test and Bartlett sphere test on the scale, it can be seen from the validity test table of the research variables that kmo value is greater than the standard value of 0.7, and the factor load is normal. That is to say, through this test, the research variables have good reliability and are suitable for factor analysis. The results are shown in Table IV.

TABLE IV. Kmo test and Bartlett test

Kaiser Meyer Olkin measure of sampling adequacy		**0.853**
	Approximate chi square	1886.762
Bartlett's sphericity test	df.	0.264
	Sig.	.000

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Exploratory factor analysis (EFA) is a method to find out the essential structure of multivariate observation variables and to reduce dimensions. On this basis, the composite reliability (CR) and average variance extracted (AVE) of the model were tested. Cr is the index value indicating the reliability and quality of internal consistency. The stronger the correlation between the indexes, the stronger the ability of potential variables to interpret them, and the better the internal consistency. Ave indicates the comprehensive interpretation ability of potential variables to all measurement variables. The larger the ave value is, the stronger the ability of potential variables to interpret the corresponding measurement variables at the same time.

III. RESULTS AND SUGGESTIONS

3.1 Results

3.1.1 Validity estimation results

See Table V for specific results.

TABLE V. Validity estimation results

Latent variable	Observed variable	Standardized factor load	S.E.	P	CR	AVE
Government support ξ_1	Promotion of smart city	0.76	0.27	***	0.91	0.72
	Urban development planning	0.79	0.19	***		
	Industrial management policy	0.83	0.32	***		
	Strength of intelligent application development	0.85	0.25	***		
Technical support ξ_2	Wireless network	0.82	0.33	***	0.91	0.72
	IOT	0.86	0.18	***		
	Cloud computing	0.85	0.31	***		
	Big data	0.85	0.28	***		
ecological environment ξ_3	Environmental quality monitoring	0.81	0.41	***	0.89	0.66
	Pollution source monitoring	0.87	0.33	***		
	New energy efficiency	0.84	0.29	***		
	Green building	0.82	0.38	***		
Infrastructure ξ_4	ecological environment	0.82	0.35	***	0.85	0.66
	Public safety	0.83	0.28	***		
	Medical treatment, education, transportation	0.79	0.39	***		

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Construction level of smart city η_1	Development situation	0.82	0.27	***	0.83	0.72
	Holistic perception	0.80	0.25	***		
Residents' sense of access η_2	Livable	0.82	0.37	***	0.80	0.67
	employment	0.78	0.26	***		
Residents nonsense of existenceη_3	Few jobs	0.71	0.42	***	0.72	0.56
	Management confusion	0.65	0.31	***		

Note: * * * means P < 0.001

It can be seen that the CR value of each potential variable is greater than the critical standard of 0.6, the ave value is greater than the critical standard of 0.5, and the factor load has passed the significance test, which shows that the design of the scale and model is reasonable.

3.1.2 Model inspection

T test method is used to test whether the parameters in the model are statistically significant. See Table VI for the results. It can be seen that the construction level of smart city does not pass the test of residents' sense of existence.

TABLE VI. Path standardization coefficient

Path			Standardization coefficient	P
Government support	→	Technical support	0.65	***
Government support	→	ecological environment	0.61	***
Government support	→	Construction level of smart city	0.57	***
Government support	→	Infrastructure	0.53	***
Government support	→	Construction level of smart city	0.50	***
ecological environment	→	Technical support	0.44	***
ecological environment	→	Construction level of smart city	0.46	***
Infrastructure	→	Construction level of smart city	0.38	***
Construction level of smart city	→	Residents' sense of access	0.50	***
Construction level of smart city	→	Residents nonsense of existence	-0.21	0.204

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Note: * * * means P < 0.001

The overall fitting degree of the model is mainly evaluated and modified according to the fitting index, and the results are shown in Table VII.

TABLE VII. Model fit

Item	χ^2/d.f.	RMSEA	GFI	AGFI	NFI	CFI	NNFI
Index number	1.59	0.060	0.887	0.797	0.853	0.931	0.937
Acceptance limit	1-5	<0.1	>0.9	>0.8	>0.8	>0.9	>0.9

From the results, except for GFI and AGFI which are lower than the acceptance limit, all the other indicators are up to the standard, and the overall fit is good, which can reflect the relationship between the observation variables and potential variables.

3.1.3 Model modification

In view of the poor correlation between "residents have no sense of existence" and other indicators in the model, and the GFI and AGFI in the fitting index are lower than the standard, the model is considered to be modified. Amos provides two model modification indexes: modification index and critical ratio. The modified index is mainly used for model expansion, and the critical ratio is mainly used for model limitation. In this paper, we consider to modify the model from the model limit, delete the "residents have no sense of existence" that has not passed the test, and the modified model is shown in Figure 2. After each path passes the test, the chi square value of the fitting index does not increase significantly, which has met the requirements. (See Table VIII)

TABLE VIII. Model fitting after correction

Item	χ^2/d.f.	RMSEA	GFI	AGFI	NFI	CFI	NNFI
Index	1.60	0.061	0.905	0.810	0.842	0.935	0.940
Acceptance	1-5	<0.1	>0.9	>0.8	>0.8	>0.9	>0.9

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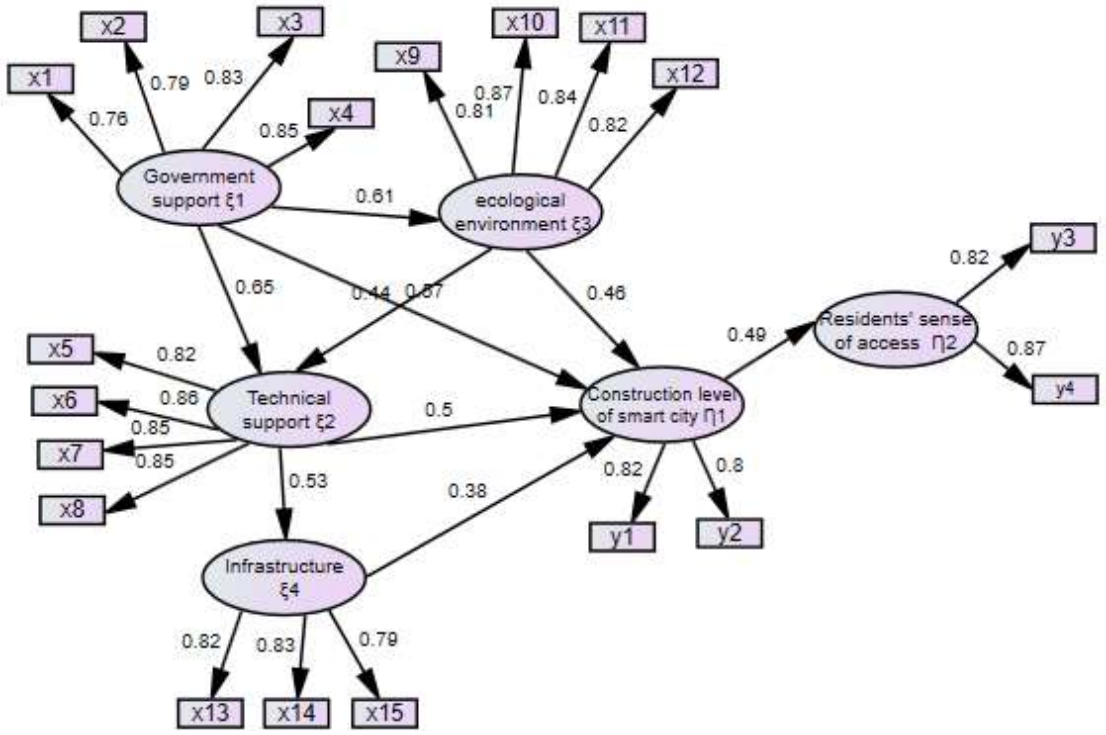

Fig 2: parameter path of smart city construction level model

3.2 Results Analysis

From the results of the final model, the path coefficients of government support, technology support, human foundation and infrastructure to the construction level of smart city are 0.57, 0.50, 0.46 and 0.38 respectively, with high load coefficient and reasonable model improvement.

Among the factors that affect the construction level of smart city, government support has the greatest impact, with a load of 0.57. Among them, the path coefficients of industrial management policy and intelligent application development are 0.83 and 0.85 respectively, which shows that these two observation variables have a greater impact on the government's support of smart city construction. It shows that the government's smart application development, information industry management, smart city publicity and planning can significantly promote the construction of smart city. The load of technical support is 0.50, which indicates that the technology represented by cloud computing, Internet of things and big data is the bottom support of urban development, and the smart city needs to upgrade itself with advanced technology. The path coefficient of ecological environment to smart city is 0.46, in which the load of pollution source monitoring and new energy use efficiency is 0.87 and 0.84 respectively, higher than the other two observation variables. On the one hand, it shows people's yearning for beautiful, clean and pollution-free environment; on the other hand, it shows that as a carrier of serving people's livelihood, people's expectation for new energy applications represented by electric vehicles and solar cells can indeed promote the operation efficiency of smart cities. The path coefficient of infrastructure construction is 0.38, which shows that the infrastructure driven by intelligence and serving people's livelihood is an important aspect

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of smart city construction.

3.3 Countermeasures and Suggestions

With the continuous promotion of smart city construction, it should be realized that the "wisdom" of a city is not only "management" and "technology", but also reflected in various aspects such as transportation, environmental protection, municipal administration, etc. its core is people-oriented.

It needs to be emphasized that the new-type smart city is a new driving force for the sustainable development of cities and will be conducive to the further modernization of the urban governance system and governance capacity; the new-type Smart City not only needs the construction of the material level, also need in the mode of thinking, behavior and social organization system with the construction. The modernization of a city must be driven by information technology, which is the core of building a new-type intelligent city. In this context, we not only need to reflect on the epidemic prevention and control in the city of the "short board" and problems, optimize the city's ecological environment.

(1) Take technological innovation as the starting point to promote the transformation of growth mode. With the rapid development of big data, mobile Internet and other information technologies as an opportunity, we will promote the transformation of urban industry to intelligence and service. Secondly, we should create an open and inclusive urban atmosphere that respects talents, especially technical talents that fit the industrial structure of smart cities. At the same time, we should break through the bottleneck of introducing talents, optimize the development environment of talents, improve the mechanism of retaining talents, and avoid the phenomenon of high-level brain drain. To explore the combination of enterprise capital and scientific research achievements in Colleges and universities, to support capable scientific and technological enterprises to participate in laboratory construction, and to promote the transformation of scientific research achievements.

(2) To improve the level of urban publicity by focusing on the excavation of urban characteristics. By using advanced technology and equipment, we can spread the cultural characteristics of the city by means of art, interaction, experience, etc., and show the way of life of the future information society to the people, so that the people can truly feel the benefits and convenience brought by the smart city. At the same time, in the interaction, we can understand the needs of the people more deeply and lay a solid foundation for the better construction of the smart city.

(3) Improve the comprehensive management level by sharing information resources. Smart cities are sustainable, so they should be planned with ideas and technologies suitable for the times. In this process, the government should not only do a good job in top-level design and make a reasonable development plan for smart city, but also explore and integrate the information resources of all departments, coordinate the management scattered in transportation, medical treatment, public security and other aspects, and form a smart implementation network with clear division of labor and cooperation and sharing. In addition, the government and enterprises should improve the network security, establish an independent network

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security department, which is specially responsible for maintaining network security and protecting relevant information. In particular, the R & D information of core technology should be protected by special personnel, special personnel and all-weather to prevent information leakage.

(4) Take the development of intelligent application as the starting point to improve the level of urban information. Convenient and comprehensive intelligent applications are the bridge between the government and the public. In the Internet era, we should focus on the development of some intelligent applications in combination with the needs of the public life, such as the road traffic comprehensive information platform, which provides the public with dynamic information of public transport, real-time urban road traffic information, public parking information, etc. At the same time, we should also pay more attention to quality rather than quantity, avoid the generation of "zombie app" and do not blindly follow the trend of development. In terms of APP maintenance, on the one hand, we can actively recruit talents within the government, on the other hand, we can cooperate with enterprises to make up for the technical deficiencies. The development of intelligent application not only brings convenience to people's life, but also provides a broader platform for the publicity of government image and regional image. It is the core purpose of the government to let people get useful information convenient for daily life and handle business quickly.

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