The Study on Smart City Construction Assessment Based On TOPSIS – "the PRD city clusters" as the case

Yongbo Liu, Zhuoling Bai

Department of management, Hunan City University, Yiyang, Hunan, 413002, China

Corresponding author is Yongbo Liu

Abstract
In recent years, the smart city construction gradually becomes a major strategic move in cities at home and abroad, in order to solve a series of problems such as population energy and environment in city development. The smart city is a systematic project, of which the smart city construction assessment is the most important part. It has been few academical research studies with the smart city level evaluation now days. A case study of "The PRD city clusters" has been covered in this paper and TOPSIS based on coefficient of entropy method has been employed in this case to assess the smart construction from several aspects: infrastructure, economic level, technology and innovation, livelihood, security, focusing on contribute to the smart city construction in order to provide a set of feasible evaluation system and help for the smart city construction.
Keywords: SMART CITY CONSTRUCTION, TOPSIS METHOD, CONSTRUCTION ASSESSMENT

1. Introduction

On the basis of the information and Internet technology, smart city is emerging in recent years and intelligently connected urban environment, industry, ecology with services in all aspects to form a new urban development model. That gradually becomes the development direction of many cities at home and abroad. The smart city is a systematic project, of which the smart city construction assessment is the most important part. Scient- ific and rational, realistic evaluation system can provide reliable data for policy makers and help them to understand the level of urban development for making right decisions. At present, the research of smart city evaluation system has not yet formed a specialized system. Since 2010, many institutions issued a series of evaluation, but required in-depth study. Construction of smart city in our country is still at its preliminary stage. A case analysis of "The PRD city clusters" has been covered in this paper and TOPSIS based on coeffi- cient of entropy method has been employed in this case to assess the smart construction, ranks and analysis each factor, and offers pra -ctical suggestions to build the smart city

2. Smart City

In 2008, IBM puts forward the concept of "smarter planet", with which they want to fight the international financial crisis and promote the development of world economy. Smart city is an important part of "smarter planet", is a systematic and complicated engineering [2].

Wisdom city has not yet to form a widely approved and unified definition. According to a lot of research at home and abroad, smart city is based on the development of internet technology such as information technology, internet of things, cloud computing, and could be organic related to infrastructure, industrial development, scientific and technological innovation,

livelihood and policy to realize an urban development model of the healthy sustainable development [3] .

3. Smart City Assessment System

More and more cities began to adopt the model of "Smart City" at home and abroad because of its many advantages. However, due to different conditions of each city, smart city construction has not unified standard, which leads many cities in the process of smart city construction with blindness, and a waste of resources that is not conducive to the development of the city [4]. Therefore, it becomes very necessary to evaluate smart city construction assessment, can help to understand the urban own development level and the status and guides smart city construction. Its system construction must follow the principle of scientific, systematic, gradation, operability [5].

3.1. evaluation model

On account of the predecessors' research results, it puts forward overall model of smart city evaluation in the paper. It argues that smart city evaluation model should include the target layer, elements layer and index layer [6]. The internal is the target layer that is smart city; the middle includes three aspects, such as the smart government, the smart economic, and the smart social; the external includes five elements: smart infrastructure, smart economy, technology and innovation, smart livelihood, smart guarantee [7].

3.2. Evaluation index system

The evaluation index is a very important part in the construction of smart city evaluation system. Its choice must follow the principle of science, systematicness, guidance and maneuverability. [8]Science means: in the process of the selection of indicators, it must be credible .Selecting indicators conforms to the fact of the smart city construction and must be persuasive. Systematicness means: the selection of indicators should be systematic analyzed and pay close attention to each indicator. Guidance means: selected indicators after analysis plays a guiding role in the smart city construction. Maneuverability means: selected indicators should be easy to measure and quantify [9].

A large number of related documents have been analyzed in this paper. It combined with the actual of smart city construction, and put Smart City Assessment System into three levels. Level 1is the goal level, that is smart city construction level; Level 2 is elements level, including five aspects: smart infrastructure, smart economy, technology and innovation, smart livelihood, smart guarantee [10]; Level 3 is the index level including thirty index under five aspects.

4. Assessment system study as the case of "the PRD city clusters"

In order to further validate that the presented evaluation model and evaluation index system is scientific and reasonable, it selected representative cities of the PRD city groups such as Guangzhou, Shenzhen and Foshan, then collected those cities' data. It verifies the effectiveness of the evaluation system is scientific and practical, analyzes the present situation of the smart city construction, and provides reference and advice for the construction of other smart cities.

4.1. TOPSIS method

TOPSI, that is Technique for Order Preference by Similarity to an Ideal Solution , It is an effective and common method in target decision, is known as the pros and cons distance method [11]. It is widely adopted in many areas such as project investment,

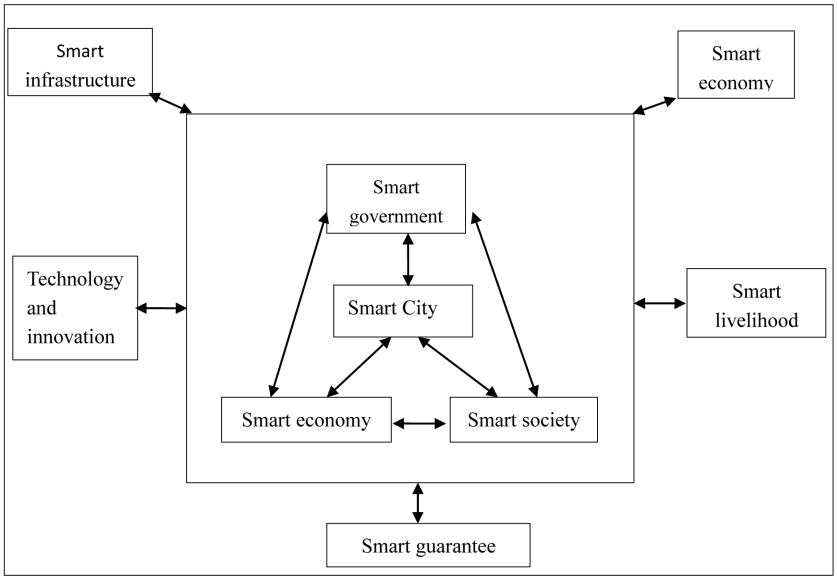

Figure 1. Smart City Evaluation Model

Table 1. Smart city evaluation index system

goal level	elements level	index level	unit
smart city construction level	smart infrastructure P1	X1 The number of mobile phone penetration rate	%
		X2 broadband penetration	%
		X3 The telecommunication business	billion
		X4 TV comprehensive population coverage	%
		X5 wireless broadband coverage	%
		X6 the percentage of urban infrastructure investment	%
		X7 college degrees per 10 000 people	individual
	smart economy P2	X 8 per capita GDP,	billion
		X9 tertiary industry proportion	%
		X10 complete passenger turnover	million people/km
		X11 passengers throughout the year	million people
		X12 local fiscal revenue	billion
		X13 total investment in fixed assets	billion
		X14 Export total	billions of dollars
	technology and innovation P3	X15 invention patent applications per 10000 people	piece
		X16 high-tech enterprises	family
		X17 high-tech industrial output	billion
		X18 cloud computing platform	fen
	smart livelihood P4	X19 urban per capita disposable income	yuan
		X20 average lifespan	year
		X21 health technician per 10000 people	individual
		X22 residents' health records by inputting rate	fen
		X23 citizen CARDS	fen
		X24 per capita total retail sales of social consumer goods	yuan
	smart security P5	X25 public service platform	fen
		X26 government information publicity integrity	fen
		X27 information resource utilization	fen
		X28 planning	fen
		X29 organization system	fen
		X30 money	fen

health care and land planning, and also can effectively improve the science and correctness of decision.

The basic principle of TOPSIS method is that, it sorted by testing evaluation objects and the most optimal solution and the distance of the worst solutions. If the evaluation objects close to the optimal solution and the most away from the bad solution at the same time, it is best; otherwise it is the worst. So, every index of the optimal solution achieves the optimal value of each evaluation index, vice versa [12].

From the above introduction of the basic principles of TOPSIS method based on coeff- icient of entropy method , it can be divided into the following several steps:

(1) The matrix is solved by means of standardi- zation of Dimensionless formula. Details are as follows:

$$Z_{ij} = x_{ij} / \sqrt{\sum_{i=1}^{m} x_{ij}^2} \quad (1)$$

(2) Calculate the entropy index:

$$Y_j = -k\sum_{i=1}^{m} f_{ij} \ln f_{ij} \quad (2)$$

In which: $f_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{m} Z_{ij}}, k = \frac{1}{\ln m}$

(3) Calculate the entropy-weight index:

$$W_j = \frac{1 - Y_j}{n - \sum_{j=1}^{n} H_J} \quad , \text{j=1, 2, 3, …n} \quad (3)$$

(4) Weight standardized matrix:

$$T=Z\cdot W \quad (4)$$

(5) Determine the ideal solution and negative ideal solution:

$$X^{+} = \left[\left(\max_i t_{ij}\right) | j \in J\right] \text{ (i=1,2,3……m)}$$

$$X^{-} = \left[\left(\min_i t_{ij}\right) | j \in J\right] \text{ (i=1,2,3……m)} \quad (5)$$

(6) Calculate the distance between each scheme and ideal scheme, including the distance with the

ideal solution d_i^+ and with negative ideal solution d_i^-:

$$d_i^+ = \sqrt{\sum_{i=1}^{n}\left(t_{ij} - X_j^+\right)^2}$$

$$d_i^- = \sqrt{\sum_{i=1}^{n}\left(t_{ij} - X_j^-\right)^2} \quad (6)$$

(7) Calculate relative close degree of each scheme:

$$C_i = d_i^+ \,/\, \left(d_i^+ + d_i^-\right) \text{(i=1,2,3…m)} \quad (7)$$

That's all steps to comprehensive analysis based on entropy weight TOPSIS method. Then, the actual data should be analyzed.

3.2. Data Collection

The Pearl River delta Urban Agglomeration, referred to as "the PRD city clusters", is one of three large urban agglomeration in our country. With Guangzhou , Shenzhen and Hong Kong at the core, the PRD city clusters is the pioneer of China's reform and opening up, including Foshan, Zhongshan, Zhuhai, Dongguan, Jiangmen, Huizhou, Zhaoqing, Macao and other cities, Also is the area with high levels of urbanization and the most active economy in the Pearl River Delta, Yangtze River Delta and Bohai Sea.

The PRD city clusters is the pioneer of China's reform and opening up and economic development, has been at the forefront of smart city construction. It builds smart tianhe city in Guangzhou, as smart Guangzhou demonstration zone; Shenzhen integrates many famous universities and enterprises from all walks of life, establishes Shenzhen smart city institute, is benefit to Shenzhen smart city construction; it promotes the smart city construction and four modernizations in Foshan, provides a new experience for intelligent city practice. So, it selected several representative cities in the pearl river delta urban agglomeration such as Guangzhou , Shenzhen and Foshan, uses the above evaluation system of the wisdom of building city, analyzes the actual data of three cities, validation the scientificity and accuracy of the evaluation system. At the same time, through the analysis of the three cities, it accurate analyzes of the level of city development and existing problems in the paper, so that can be sum up experience, promote urban construction and provide useful experience and advice for our urban construction in our country.

The data used in this article Collected from the NBS (national bureau of statistics) website and Statistics Yearbook of Guangzhou, Shenzhen and Foshan.

Table 2. The related data of Guangzhou, Shenzhen and Foshan

Index \ Data City	Guangzhou	Shenzhen	Foshan
X1	202.1	268.6	164.4
X2	130.4	64.5	86.6
X3	2275.2	3403.5	1690.4
X4	100.0	100.0	99.0
X5	4.0	2.0	4.0
X6	24.1	33.7	19.0
X7	19228.0	17175.0	9469.0
X8	9.7	11.0	9.1
X9	61.5	53.5	34.6
X10	1879.0	721.0	108.3
X11	6.8	16.8	3.5
X12	3978	1339	1111
X13	3413.6	2136.4	1936.3
X14	1161.7	4141.0	609.0
X15	21.1	60.7	3.8
X16	1250.0	3086.0	500.0
X17	3.5	4.5	3.0
X18	3.0	2.0	1.0
X19	3.44	3.65	3.07
X20	79.0	77.7	77.3
X21	79.4	55.4	49.5
X22	5.0	3.0	5.0
X23	2.0	1.0	2.0
X24	3.52	2.90	2.35
X25	5.0	4.0	4.0
X26	3.9	3.8	4.4
X27	3.0	5.0	3.0
X28	3.0	5.0	5.0
X29	5.0	1.0	5.0
X30	3.0	3.0	5.0

4.3. calculation results

According to the collected data and Using the detailed steps (1)-(30) based on entropy weight TOPSIS method, it can be primarily concluded X1 - X30 entropy weight of each index.

Table 3. Each index weight

Index	X1	X2	X3	X4	X5	X6
Weight	0.0370	0.0410	0.0229	0.0150	0.0685	0.0135
Sort	11	9	19	28	1	29
Index	X7	X8	X9	X10	X11	X12
Weight	0.0166	0.0645	0.0516	0.0371	0.0152	0.0576
Sort	24	3	7	10	27	5
Index	X13	X14	X15	X16	X17	X18
Weight	0.0183	0.0173	0.0192	0.0586	0.0369	0.0308
Sort	22	23	21	4	12	14
Index	X19	X20	X21	X22	X23	X24
Weight	0.0165	0.0107	0.0221	0.0245	0.0157	0.0307
Sort	25	30	20	18	26	15
Index	X25	X26	X27	X28	X29	X30
Weight	0.0266	0.0289	0.0364	0.0423	0.0661	0.057
Sort	17	16	13	8	2	6

Table 4. Elements level scores

goal level	Elements level	Score
smart city construction level	smart infrastructure	0.2145
	smart economy	0.2616
	technology and innovation	0.1455
	smart livelihood	0.1202
	smart guarantee	0.2573

According to calculation with the above steps (4) - (7), each city ranking results can be obtained in the end by calculating the distance of ideal solution and negative ideal solution and getting relative close degree.

Table 5. Relative approach degree and Rank

City	Relative approach degree d_i	Rank
Guangzhou	0.6357	1
Shenzhen	0.6019	2
Foshan	0.4793	3

4.4. Results and Discussion

The above data are calculated and corresponding results are obtained and be analyzed with it. From the essential factor layer, the five factor score in table 4 are: smart infrastructure 0.2616, smart economy 0.2145, science and technology and innovation 0.1455, smart livelihood 0.1202, smart security 0.2573.

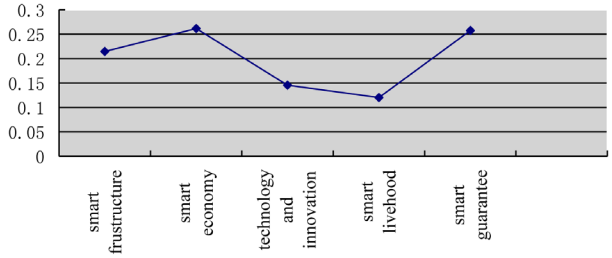

Figure 2. Factors score

Figure 2 shows that the five factor scores are relatively uniform, smart economy , smart security and smart infrastructure ranked the first three and had little difference., smart economy , smart security, smart infrastructure. The reasons of high scores about three factors are not only more related index but also high score with each index, which indicates that three factors play an important role in the smart city construction, and can not be ignored.

The role of smart economy is in the first place, wisdom city development need to develop smart economy at the same time, form a complete set of policy support and must also be kept pace with infrastructure construction and the construction of intelligent city. Technology and innovation, the wisdom of the people's livelihood in the role of the five elements is relative small function and there are high weight indicators under these two elements. So in the process of smart city development, innovation of science and technology, wisdom, also cannot people's livelihood. It cannot ignore but balance development with technology and innovation and the wisdom of the people's livelihood

From the index Layer, the top five index's relative weight respectively is 0.0685, 0.0661, 0.0645, 0.0586, 0.0576 with X5 wireless broadband coverage, X29 organization system, X8 per capita GDP, X16 high and new technology enterprise, X12 local fiscal revenue. From the rank of these indicators, wisdom in the process of intelligent urban development, it plays a very important role with the wisdom of economic development and policy environment. The weight of wireless broadband coverage ranks first indicated that adapting to the trend of mobile Internet is very important to develop smart city. Smart security is second and smart economic is third that indicates the importance on smart city. At the same time, the bottom five index's relative weight respectively is 0.0107, 0.0135, 0.0150, 0.0152,0.0157 , among all the indicators, X20 average lifespan, X6 the percentage of urban infrastructure investment, X4 TV comprehensive population coverage, X11 passengers throughout the year and X23 citizen CARDS.

In addition, the top ten of index weight is 0.5443, the sum accounts for more than half, and at the bottom ten of index weight is 0.158, the sum accounts for only about 1/ 6.

The urban ranking result is Guangzhou first, Shenzhen second, Foshan third. It indicates that the evaluation system is found to conform with the actual data and scientifically evaluates the wisdom city development level by combining and analyzing index weight and original data

5. Suggestions to smart urban construction

It provides some useful suggestions for the development of smart city through the above based on the analysis of the instance.

In the five elements of wisdom city, smart economic is the base status, therefore, the key is to develop it in smart city development. We should fully grasp the development of information technology and promote the transformation and upgrade economy, grasp the tide of network based on the Internet of things, promote the smart city construction.

Smart security is supported. Intelligent security plays an important role in support in smart city construction. Government should be changed function,

is guardians of the wisdom urban construction. The construction of intelligent city could be promoted according to reasonable planning, system organization, strong investment and improve efficiency.

Wisdom infrastructure is a prerequisite. No matter how the development of intelligent city, the premise is the perfect smart infrastructure. It should be advance planning, rational layout, build and perfect smart infrastructure, improve the wisdom in the development of intelligent city. Only if hard power as the premise, can the soft power enhance, the intelligent construction of city promote.

Technology and innovation is motivation. Although in the five elements, technology and innovation gets a relative lower score, but in the process of construction of wisdom city must not ignore science and technology and innovation.

This smart city's nature is the innovation of the urban development phase, its continuous development of power is technology and innovation. So, in the process of smart city construction, science and technology and innovation should be attach importance and become the inexhaustible driving force of smart urban development.

The wisdom of the people's livelihood is the goal. The development of smart city, not only to solve the urban problems of energy and environment, also to improve and change the urban residents' way of life. Therefore, in the process of intelligent city construction, smart livelihood should be always attached importance and make the residents to enjoy the advantages of city wisdom.

6. Conclusion

Smart city as a new urban develop- ment mode is becoming development direction of more and more cities at home and abroad. Now days, development of Smart city is in the ascendant and still exist many problems and confusion in the process of its development. In this case, the smart city construction level evaluation system can effectively assess the smart city development situation, found shortage, sum up experience and provide advice that has important significance with the theory and practice of intelligent city development.

According to the practice of our country urban development wisdom, it puts forward the five elements of smart urban development and the evaluation index system of smart city in this article which Based on a large number of research literatures. Three cities are analyzed with the method of TOPSIS based on coefficient of entropy such as Guangzhou, Shenzhen, Foshan .The result show that this evaluation system is scientific and feasible, provides the feasible suggestion further according to the results of the analysis of the current smart city construction in our country to promote the development of smart city.

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