Research on Kunming Smart City Development Based on TOPSIS Model

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Abstract. This paper collected wisdom city from 2013 to 2018 the relevant index data, build the evaluation model of urban development, kunming wisdom using TOPSIS method and entropy weight method to the development level of wisdom cities, find wisdom in kunming, problems existing in the process of urban development, and puts forward relevant Suggestions and countermeasures, hoping to provide some reference to the development of wisdom in our country city.

1. Introduction

Smart city is to use information and communication technology means to sense, analyze and integrate key information of the core system of urban operation, so as to make intelligent response to various demands including people's livelihood, environmental protection, public safety, urban services and industrial and commercial activities. Its essence is to make use of advanced information technology to realize the intelligent management and operation of the city, so as to create a better life for the people in the city and promote the harmonious and sustainable growth of the city. China has established three national smart city pilot lists successively. Kunming wuhua district is the first batch of national smart city pilot. As the provincial capital city, kunming's smart city development will definitely play a leading and guiding role for other counties and cities in the province. Based on the current situation of smart city development in yunnan province, this paper takes kunming as the main object to study its smart city development level, hoping to contribute to the domestic urban economic development and smart city construction.

2. Development status of smart city in kunming

2.1. The development process of smart city

In July 2016, jiangsu planning and design institute of posts and telecommunications completed the top-level design of kunming smart city (2016-2020), which outlined the development blueprint. In October 2016, the "two offices" of kunming issued the implementation opinions on accelerating the construction of smart cities (2016-2018). Later, a leading group of work was set up. The leading group of kunming smart city construction was set up by the municipal party committee and municipal government, with the secretary of the municipal party committee as the group leader, the mayor as the executive deputy group leader, and the deputy mayors as the deputy group leaders. Leading group under the office, municipal standing committee sun tao as office director. Three smart city related institutions have been
set up. One is the big data administration bureau of kunming city; Second, the establishment of kunming information center; Third, it established kunming smart city investment company. To organize and implement the ministry of finance PPP project under the leadership of leading group and relevant institutions. In July 2017, the feasibility study plan of kunming smart city (phase I) PPP project was approved by a panel of 7 domestic and foreign well-known experts, including zhou chenghu, academician of the Chinese academy of sciences, and wang yukai, deputy head of the Chinese society for administrative system reform.

2.2. Phase I construction of kunming smart city
The first phase of kunming smart city construction includes 8 special projects, including government public service platform, citizen service platform, urban operation and management center, information security, city smart card, smart transportation, smart tourism and smart education.

2.3. Kunming smart city construction goals
By 2020, the construction of kunming smart city will achieve remarkable results, forming ubiquitous beneficial services for the people, transparent and efficient online government, integrated innovative information economy, precise and fine urban governance, and safe and reliable operation system. Data connection, business connection, safety connection and finance connection of the whole city are realized. Through the construction of kunming smart city, the cohesion, radiation and driving force of the city will be enhanced, and the construction of kunming regional international central city will be promoted.

3. Construction of intelligent city development level evaluation index system

3.1. Construction of indicator system
By collecting and sorting literature, relevant legal documents and smart city development planning documents, relevant indexes suitable for kunming smart city evaluation are sorted out, as shown in table 1.

3.2. Evaluation method
In this paper, entropy weight method and TOPSIS method are combined, and the results of entropy weight method are put into TOPSIS for operation. The operation steps are as follows:
TOPSIS method is also called preference order evaluation method or ideal solution approximation ranking method. By calculating the distance between the evaluation object and "ideal solution" and "negative ideal solution", the relative close state of each evaluation object and "ideal solution" is obtained, and each evaluation object is ranked in a certain order, which is often used in multi-objective decision analysis. Calculation process of TOPSIS method:
A. Construction of evaluation matrix. Suppose there are m evaluation years and an evaluation indexes, and xij is used to represent the evaluation value of the JTH index of the ith criterion. The original matrix can be obtained from the original data $x = \{x_{ij}\}^{m \times n}$, (i=1, 2…m; j=1,2,…n). Where xij is the value of the JTH evaluation index of the ith evaluation object.
B. Carry out corresponding normalization treatment on the original matrix. The standardization methods are as follows:
Table 1 Kunming smart city development evaluation index system

| First-level indicators          | The secondary indicators                                      | Serial number |
|--------------------------------|----------------------------------------------------------------|---------------|
| Infrastructure construction Y1 | Ev charging piles                                              | S1            |
|                                | Fixed Internet broadband access user (10,000 households)       | S2            |
|                                | Mobile phone users (10 thousand)                               | S3            |
|                                | Telecom revenue (100 million yuan)                             | S4            |
| Smart economy development Y2  | Tertiary industry value (100 million yuan)                     | S5            |
|                                | Amount of R&D fund input (ten thousand yuan)                   | S6            |
|                                | Fiscal expenditure on science and technology (ten thousand yuan)| S7            |
|                                | The proportion of fiscal expenditure on science and technology (%)| S8            |
|                                | Revenue from local governments' general public budgets (100 million yuan) | S9            |
|                                | Expenditure from local general public budgets (100 million yuan) | S10           |
|                                | Total imports and exports                                      | S11           |
|                                | Total revenue of postal service (100 million yuan)             | S12           |
| Technological innovation development Y3 | Information transmission, software and information services                  | S14           |
|                                | Number of scientific research and technical service personnel (person) | S15           |
| Smart life Y4                  | High school gross enrollment rate (%)                          | S16           |
|                                | Public health records filing rate (%)                          | S17           |
|                                | New energy vehicle ownership (ten thousand)                    | S18           |
|                                | Express delivery volume (ten thousand pieces)                  | S19           |
| Intelligent environment Y5     | automatic air quality monitoring station number                | S20           |
|                                | Green coverage area (km2)                                      | S21           |
|                                | Good air quality rate (%)                                      | S22           |
|                                | Green coverage rate (%)                                        | S23           |

\[
rij = xij / \sum_{i=1}^{m} xij (i = 1, 2, ..., n) \tag{1}
\]

\[
R = \begin{bmatrix}
  r_{11} & \cdots & r_{1n} \\
  \vdots & \ddots & \vdots \\
  r_{m1} & \cdots & r_{mn}
\end{bmatrix}
\]

C. Calculate weight by entropy. The decision-making information of each indicator is expressed by entropy value \( e_j \), and the calculation formula is as follows:

\[
e_j = -k \sum_{i=1}^{n} rij \ln rij, (j = 1, 2 \ldots n) \tag{2}
\]
In equation (2), \( k \) is determined according to the number of evaluation criteria, is constant \( k = \frac{1}{\text{LNM}} \), and \( 0 \leq e_j \leq 1 \). \( G_j \) represents the dispersion degree of the value of the JTH indicator, \( g_j = 1 - e_j \), so the weight of the JTH indicator is:

\[
w = g_j / \sum_{j=1}^{n} g_j, (j = 1,2,...,n)
\]

\[(3)\]

D. Construct weighted normalization matrix. By multiplying with the weight of each index, the weighted normalization matrix of the scheme is obtained:

\[
V = (v_{ij}) = \begin{bmatrix}
W_1 r_{i1} & \cdots & W_n r_{in} \\
\vdots & \ddots & \vdots \\
W_1 r_{n1} & \cdots & W_n r_{nn}
\end{bmatrix}
\]

Determine ideal solution \( V^+ \) and negative ideal solution \( V^- \)

\[
V^+ = \left\{ \left( \max_{p_{ij}} \left| j \in j_1 \right), \left( \min_{p_{ij}} \left| j \in j_2 \right), \right. \right. i = 1,2,...,m \right\};
\]

\[
V^- = \left\{ \left( \min_{p_{ij}} \left| j \in j_1 \right), \left( \max_{p_{ij}} \left| j \in j_2 \right), \right. \right. i = 1,2,...,m \right\},
\]

\[(4)\]

F. Calculate the distance between the corresponding evaluation value and the ideal solution and the negative ideal solution

\[
D_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{ij}^+)^2}, (i = 1,2,...,m)
\]

\[
D_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{ij}^-)^2}, (i = 1,2,...,m)
\]

\[(5)\]

G. Calculate the proximity coefficient for each year of the evaluation criteria.

\[
C_i = D_i^- / (D_i^+ + D_i^-), (i=1, 2... m)
\]

Where, \( 0 \leq c_i \leq 1 \), the closer \( c_i \) is to 1, the closer it is to the ideal solution.

H. Rank the evaluation objects accordingly.

According to the value of proximity coefficient obtained above, the fit degree between the evaluation object and the optimal evaluation target can be known. The object with the best evaluation result should be near the optimal solution, while the one with the worst one is furthest away. According to evaluation the 0 or less \( c_i \) 1 or less hierarchies of the number of objects, such as, for nearly 5 years to evaluate urban seismic ductility construction condition will each year evaluation results respectively for \((s1, s2, s3, s4, s5)\), depending on the model conditions, its annual value between 0 ~ 1 press close to, and its evaluation of the year is divided into five grades (best level 1, level 2 times 5 worst) as shown below:
Table 2: Quantitative grade quantitative table

| plan | Proximity score | rating | Proximity score segment |
|------|----------------|--------|------------------------|
| s1   | C1             | Level 5| 0.00-0.20              |
| s2   | C2             | Level 4| 0.20-0.40              |
| s3   | C3             | Level 3| 0.40-0.60              |
| s4   | C4             | Level 2| 0.60-0.80              |
| s5   | C5             | Level 1| 0.80-1.00              |

3.3. Analysis of Kunming smart city development evaluation results

3.3.1. First-level index weight analysis

Table 3: Ranking table of first-level index weight

| Index                             | Weight       |
|-----------------------------------|--------------|
| Infrastructure Y1                 | 0.417155     |
| Smart life Y4                     | 0.323601     |
| Intellectual economy Y2           | 0.183668     |
| Science and technology innovation Y3 | 0.066592   |
| Smart environment Y5              | 0.008984     |

(1) Infrastructure Y1

Table 4: Weight table of secondary indicators of infrastructure

| Infrastructure Y1 | Ev charging piles | S1 | 0.3820 |
|-------------------|-------------------|----|--------|
| Fixed Internet broadband access user (10,000 households) | S2 | 0.0326 |
| Mobile phone users (10 thousand) | S3 | 0.0021 |
| Telecom revenue (100 million yuan) | S4 | 0.0005 |

The weight of infrastructure is 0.4172, accounting for the highest proportion in the first-level index, which is closely related to the initial stage of smart city development in Kunming from 2013 to 2018. In 2013, Wuhua District of Kunming City was listed as one of the first batch of smart city pilot projects in the country, after which the Kunming government paid more attention to the development of smart city. Smart city infrastructure construction is the cornerstone of smart city development, so Y1 index accounts for a relatively high proportion at this stage. The weight of S2, S3 and S4 is low, mainly because these indicators have reached a high level before 2013. After 2013, although they have been improved year by year, the growth rate is slow, which has little impact on the overall level of smart city infrastructure.

(2) Intellectual economy Y2

The weight of smart economy index is 0.1837, ranking the third among the first-level indexes. Imports and exports, postal business gross weight is higher, which explain the Kunming economic development is good, but for wisdom and economic influence of R&D funds input amounts, fiscal expenditure for science and technology, fiscal expenditure for science and technology indexes of fiscal expenditure proportion of weight is very low, this shows that Kunming economic importance is not enough for wisdom.
### Table. 5 Secondary indicator weight of smart economy

| Intellectural economy Y2 | Tertiary industry value (100 million yuan) | S5 | 0.0102 |
|--------------------------|-------------------------------------------|----|---------|
|                          | Amount of R&D fund input (ten thousand yuan) | S6 | 0.0204 |
|                          | Fiscal expenditure on science and technology (ten thousand yuan) | S7 | 0.0079 |
|                          | The proportion of fiscal expenditure on science and technology (%) | S8 | 0.0009 |
|                          | Revenue from local governments' general public budgets (100 million yuan) | S9 | 0.0030 |
|                          | Expenditure from local general public budgets (100 million yuan) | S10 | 0.0044 |
|                          | Total imports and exports | S11 | 0.0412 |
|                          | Total revenue of postal service (100 million yuan) | S12 | 0.0955 |

(3) Science and technology innovation Y3

### Table. 6 Weight of secondary indicators of scientific and technological innovation

| Science and technological innovation Y3 | Patent applications (pieces) | S13 | 0.0569 |
|-----------------------------------------|-----------------------------|-----|---------|
|                                        | Information transmission, software and information services | S14 | 0.0088 |
|                                        | Number of scientific research and technical service personnel (person) | S15 | 0.0009 |

The index weight of scientific and technological innovation is 0.0666, ranking the fourth in the first level index. The high weight of the number of patent applications indicates that citizens' awareness of maintaining intellectual property rights has been significantly improved, which is conducive to the improvement of the overall level of scientific and technological innovation in the city. However, the weight of relevant practitioners' indicators is low, which is contrary to the requirements of smart city development.

(4) Smart life Y4

### Table. 7 Secondary index weight of Smart Life

| Smart life Y4 | High school gross enrollment rate (%) | S16 | 0.0001 |
|---------------|--------------------------------------|-----|---------|
|               | Public health records filing rate (%) | S17 | 0.0032 |
|               | New energy vehicle ownership (ten thousand) | S18 | 0.1777 |
|               | Express delivery volume (ten thousand pieces) | S19 | 0.1426 |
The index weight of smart life is 0.3236, ranking the second in the first level. The development of smart city is to make people live in the city more happily. Convenient travel mode, high quality of life, healthy body and pleasant environment are all the goals and pursuits of the development of smart city. Smart living in Kunming has developed rapidly from 2013 to 2018, and the technology and concept of smart city are reflected in many aspects such as education, health, transportation, etc. With the development of 5G technology, big data and other technical conditions, the future city will be more intelligent.

(5) Smart environment Y5

Table 8 Secondary index weight of smart environment

| Smart environment Y5 | Secondary index weight | Automatic air quality monitoring station number S20 | 0.0000 |
|----------------------|------------------------|--------------------------------------------------|--------|
| Smart environment Y5 | Smart environment Y5   | Green coverage area (km2) S21                    | 0.0078 |
| Smart environment Y5 | Smart environment Y5   | Good air quality rate (%) S22                    | 0.0003 |
| Smart environment Y5 | Smart environment Y5   | Green coverage rate (%) S23                      | 0.0009 |

The weight of intelligent environment index is 0.009, which is the last of the five first-level indexes. The main reason for the low development of smart environment in Kunming is that Kunming has achieved excellent results in environmental protection. If a large number of social resources are invested in the development of smart environment, it will undoubtedly be a waste of public resources. In recent years, Kunming has invested little public resources in the automation of urban environmental monitoring, which is basically in a stagnant state. Kunming city environmental indicators are better, more should strengthen its monitoring efforts, maintain a better level of ecological environment.

3.3.2. Secondary index weight analysis

Table 9 Ranking table of weight of each secondary index

| Secondary index                              | Serial number | The weight | Weighted ranking |
|----------------------------------------------|---------------|------------|------------------|
| Ev charging piles                            | S1            | 0.3820     | 1                |
| New energy vehicle ownership (ten thousand)  | S18           | 0.1777     | 2                |
| Express delivery volume (ten thousand pieces)| S19           | 0.1426     | 3                |
| Total revenue of postal service (100 million yuan) | S12         | 0.0955     | 4                |
| Patent applications (pieces)                 | S13           | 0.0569     | 5                |
| Total imports and exports                    | S11           | 0.0412     | 6                |
| Fixed Internet broadband access user (10,000 households) | S2          | 0.0326     | 7                |
| Amount of R&D fund input (ten thousand yuan) | S6            | 0.0204     | 8                |
| Tertiary industry value (100 million yuan)   | S5            | 0.0102     | 9                |
| Information transmission, software and information services | S14   | 0.0088     | 10               |
| Fiscal expenditure on science and technology (ten thousand yuan) | S7    | 0.0079     | 11               |
| Green coverage area (km2)                    | S21           | 0.0078     | 12               |
| Expenditure from local general public budgets (100 million yuan) | S10 | 0.0044 | 13               |
| Public health records filing rate (%)        | S17           | 0.0032     | 14               |
As shown in the table above, the weight of the top five secondary index respectively, the electric car charging pile number, new energy car ownership, express delivery business, postal service revenue, number of patent applications, the indicators of kunming wisdom has important effects on the level of city development, including new energy vehicles and charging pile mainly reflects the development of new energy vehicles in kunming, kunming, the capital of patent application is to reflect the innovation ability. These indexes fluctuated greatly during the research period, and all the five indexes showed a rapid rising trend, which played a significant role in the improvement of the development level of smart cities.

Weight of the lowest five indicators are respectively the number of scientific research and technical service, telecom business income, the rate of good air quality, number of high school gross enrollment ratio, air quality automatic monitoring station, in which the rate of good air quality and air quality automatic monitoring station number reflects the development of kunming city environmental wisdom, low weight mainly because of this a few indicators at higher or lower levels, and during the study period index volatility is small, for the overall development of the city without wisdom.

3.3.3. Analysis of kunming smart city development trend

(1) Overall trend of smart city development in kunming.

According to the calculation results of TOPSIS, the overall development trend chart of kunming smart city from 2013 to 2018 is drawn, as shown in figure 1.

**Figure. 1** Overall trend of smart city development in kunming from 2013 to 2018
2013-2015 kunming wisdom city development level is low, mainly because of the accumulation of two years in the start stage, wisdom urban pilot just determined that need the policy environment, citizen consciousness, social development and economic base and so on various aspects support, only the accumulation of stock in the short term, completed in 2015 in the stock of accumulated realize the qualitative change, wisdom urban development by leaps and bounds. Among them, the number of electric vehicles, the establishment of electronic medical records, the charging piles of electric vehicles and other indicators rapidly increased after 15 years, vigorously promoting the development of kunming smart city.

(2) Development trend of kunming smart city index

It can be seen from the development trend chart of first-level smart city indicators in kunming that the development speed of infrastructure and smart life is fast. Smart economy and scientific and technological innovation have a high start, but lack of motivation and slow improvement; Insufficient investment in smart environment.

3.4. Problems existing in the development process of kunming smart city

3.4.1. Low level of smart city infrastructure construction. Kunming wisdom city construction has just started, the wisdom of some emerging urban development is also relevant industries, such as the electric car industry, the electric car ownership in kunming, reached 16900 at the end of 2018, accounts for 0.63% of the city's motor vehicle ownership, this is mainly because the electric car as a new means of transportation, has not been accepted by most people, in addition, electric cars in such aspects as charging technology, maintenance technology is not yet mature, and related supporting infrastructure (charging pile, etc.) are not completed, under the influence of various factors, cause the overall construction level is not high.

3.4.2. Lack of urban scientific and technological innovation ability. Scientific and technological innovation ability is a powerful power to promote the rapid development of a city. If a city lacks scientific and technological innovation ability, its development will be hindered. From 2013 to 2018, the number of employees engaged in information transmission, software and information services in kunming even decreased, which indicates that kunming is not attractive to these employees in employment, leading to a large number of related brain drain. The number of employees engaged in scientific research and technical services increased by 7,534 between 2013 and 2018, and reached 53,134 at the end of 2018, accounting for 4% of the total number of employees in urban units. That is
to say, the number of employees engaged in scientific and technological innovation in Kunming has a small base and a slow growth rate, which restricts the development of the city's scientific and technological innovation ability.

3.4.3. The government's R&D support is insufficient. The government's support for R&D is mainly reflected in the proportion of fiscal expenditure on science and technology in fiscal expenditure, which was basically maintained at around 2% from 2013 to 2018, indicating the government's insufficient support for R&D. In economic indicators, the R&D funds input amounts from 2013 to 2018, more than doubled to society on the importance of R&D improve soon, but the government should still play its policy leading and guiding role, in major cities across the country under the background of "a bidding war", how to improve urban competitiveness to retain more advanced talents, the government and related departments to pay attention to the problem.

3.4.4. Slow development of smart environment. Kunming city ecological environment around the country at a higher level, air quality standard number of days of remain above 90%, the ecological environment indicators also ranks high, meanwhile, Kunming somewhat lax in environmental monitoring, the Kunming city covers an area of 98 square kilometers, air quality automatic monitoring station number only seven, and in 2013, and has not increased. Good natural ecological environment needs monitoring and protection, environmental protection departments should strengthen the supervision of the environment.

4. Countermeasures and Suggestions to improve Kunming smart city development level

4.1. Upgrade the level of smart city infrastructure construction
The level of smart city infrastructure construction directly affects the level of smart city. Transportation, health care, education, tourism, residents, and so on, all these functions of wisdom city development need the infrastructure to provide security, self-driving technology, electric vehicle charging pile, intelligence community, etc., all want to put these construction projects on the agenda as soon as possible, establish a comprehensive, three-dimensional, fully cover the wisdom of the urban infrastructure networks.

4.2. Increase investment in R&D to provide strong impetus for the sustainable development of the city
The development of smart cities needs a lot of support from science and technology. Both the government and the society should pay attention to the investment of R&D. As a policy maker and guide, the government should actively guide social enterprises to develop their scientific research departments, and formulate relevant supporting policies to retain scientific research staff, enhance urban competitiveness and improve the income and treatment of scientific research staff, so as to provide a good policy environment for scientific research staff.

4.3. Strengthen automatic environmental monitoring
Kunming automatic environmental monitoring equipment is mainly for the monitoring of atmospheric environment, in addition to the monitoring of atmospheric environment, should also introduce water, dust, radioactive substances and other automatic monitoring equipment. A large number of social resources have been invested in the treatment of Dianchi Lake, and some results have been achieved. The introduction of automatic monitoring equipment can monitor several dianchi lake rivers into yunnan province, and timely find the pollution sources. In Dianchi Lake, reasonable water quality monitoring equipment should be deployed to focus on the improvement of areas with poor water quality. In addition, Kunming is in the stage of rapid urbanization, and there is a lot of urban infrastructure construction. In the construction process, noise and dust are inevitable. Therefore, the installation of relevant automatic monitoring devices on construction sites can effectively alleviate these problems.
References

[1] Henry S. Rowen. Smart Green Cities [EB/OL]. http://fsi.stanford.edu/research/smart_green_cities/, 2013

[2] Rachel Carson. Silent Spring [M]. Houghton Mifflin Company, 2002

[3] Shen jun. A new concept of green city -- sustainable development, which comes from the construction of xujiahui park [J]. Land greening, 2003 (2): 18.

[4] Ye zhangsheng, wang lijun, liu weimin, zhu shenggao. Building a green city is the inevitable choice for shiyen city to realize sustainable development [J]. Journal of yunyang teachers college, 2003 (10): 29-32.

[5] Huang qixin. Research on green city development strategy oriented to cultural innovation -- a case study of wuhan city [J]. Business research, 2006 (5): 134-136.

[6] Zeng jian, zuo chang 'an. Green urban design theory based on the concept of sustainability and harmony [J]. Journal of architecture, 2006 (12): 10-13.

[7] Chen kishi. Green city should put people in the first place [J]. Open herald, 2010 (12): 36-37.

[8] Jia zi. There is a green city in everyone's heart [J]. Green China, 2008 (5): 46-48

[9] Xu ruoyun. Preliminary exploration on several architectural issues in western smart city theory [D]. Tsinghua university, 2014

[10] Chen jinmei. Vision and evaluation of smart city -- countermeasures and Suggestions for smart tianjin construction [J]. Tianjin science and technology, 2013 (4): 80-82.