Study of County Level Government's E-Government Efficiency Evaluation in Sichuan Province Based on DEA

Yu Liu(✉), Jiawei Liu, Zhaohui Zhang, and Liangqing Zhang

School of Political Science and Public Administration,
University of Electronic Science and Technology of China,
Chengdu 611731, People's Republic of China
laujames_work@163.com

Abstract. The county government plays a fundamental role in the Chinese governance. The e-government system of it can directly reflect the quality and efficiency of its service. Thus, it's significant to evaluate the efficiency of the e-government at county level. Nowadays, there're plenty of methods to do this kind of evaluation. This paper mainly uses principal component analysis to establish the index system, and adopts the CCR and BCC models, two of the data envelopment analysis DEA, to reflect the current input and output efficiency of 147 counties' e-government in Sichuan Province. The analysis reveals that most of the e-governments' comprehensive efficiency, technical efficiency and scale efficiency are non-DEA effective in county level governments of Sichuan Province, and the differences in development among them are quite distinctive. What's more, the local governments' information department should embark on improving their investment scale and technical efficiency in order to enhance the efficiency of e-government.

Keywords: E-government · County government · Data envelopment analysis · Efficiency

1 Introduction

The county government has long been the basis of administration management and state governance in China. It faces to the grass-roots and serves them directly. Thus, the efficiency of its operation can greatly influence the overall quality of people's life and production. Nowadays, as an effective way of improving administrative efficiency and transparency, the e-government has been praised highly by many countries. And China has also launched the Government Online Project since 1999. In fact, the construction of e-government within the county level is a very important part of China's e-government development, as well as the terminal node to the provincial level e-government, and governments should pay great attention to e-government construction at county level for constructing mature e-government system structure [7]. To promote the healthy and

J. Xu et al. (eds.), *Proceedings of the Eleventh International Conference on Management Science and Engineering Management*, Lecture Notes on Multidisciplinary Industrial Engineering, DOI 10.1007/978-3-319-59280-0_32

sustainable development of a county e-government, an evaluation of its efficiency which may help improve its service quality is strongly required.

Evaluation systems like the Global E-government Evaluation from the UN [11], the "eEurope" Strategic Assessment System from the EU [3] and the Overall e-government Maturity Assessment from the Accenture company [1] are international representatives. While in China, it also has assessment models like the CCW Research [12], the China Software Testing Center [4], the CCID Consulting [5] and the CCTC [2].

According to the actual situation, the E-government efficiency evaluation index system was constructed from different perspectives and the corresponding analysis methods are used to evaluate the efficiency of the E-government. Extraordinary representatives: Luo and Shi [10] introduced genetic algorithm optimized to BP neural network weights and thresholds after reducing the established evaluation index system by rough set, and established e-government website evaluation model based on genetic neural network algorithm; Rorissa, Demissie and Pardo [13] used benchmarking to assess the strengths and limitations of six frameworks for computing e-government indexes; Luna et al. [9] used data envelopment analysis (DEA) to show how efficient are Mexico state governments in their use of certain inputs to produce high quality e-government portals; Zdjelar [17] measured efficiency of Croatian regional government implementation by Balanced Scorecard Method; Song and Guan [14] utilized a super efficiency slack-based measure (SBM) model to evaluate the e-government performance of environmental protection administrations in the 16 cities of Anhui Province; Kao [8] evaluated the e-government of 21 European countries based on the concept of Pareto optimality and developed a compromise programming model to rank these nations; Wu and Guo [15] used method of DEA to evaluate e-government performances of 31 provincial government websites in China and concluded that most of these provincial government websites operated at an inefficient level and in a bad manner.

To sum up, the achievements of researches on the e-government's efficiency provide a useful reference to the study. However, the evaluation of Chinese e-government's efficiency has not yet had a uniform index system. Most researches are focusing on the overall efficiency of the provincial research objects and few investigate the input-output efficiency of e-government from the perspective of e-government at county level. Therefore, this paper attempts to use principal component analysis to build the evaluation index system of county level e-government's efficiency, and adopt the DEA model to evaluate the efficiency of e-government in 147 counties (including county level cities) of Sichuan Province to provide decision-making reference for the promotion of county level e-government's efficiency.

The remainder of this paper is organized as follows. In the first half of Sect. 2, we briefly discuss the principle of principal component analysis and the practical application value of it. In the second half of Sect. 2, we narrate the construction of CCR model and BCC model of DEA which will be used for e-government efficiency evaluation. The process of e-government efficiency evaluation is presented in Sect. 3 which includes the samples selection, data collection, the establishment of evaluation index system and the model solution. On the basis of the solution, the analysis of the current situation in Sichuan Province and the suggestions for the ineffective county level government are given in Sect. 4. Finally, we conclude with a summary of this paper and prospect about evaluation of e-government in Sect. 5.

2 The Method of E-Government Efficiency Evaluation

2.1 Principal Component Analysis

On the premise of the least information loss, principal component analysis is a statistical procedure that uses the thought of dimension reduction to convert a set of multiple indexes with possible correlation into a few linearly uncorrelated comprehensive indexes.

The basic principles of principal component analysis are as follows:

We assume that there are p objects that each object is described by n indexes. In this way, we can constitute a data matrix:

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & & \vdots \\ x_{p1} & x_{p2} & \cdots & x_{pn} \end{pmatrix} = (X_1, X_2, \cdots, X_n). \quad (1)$$

$X_1, X_2, \cdots, X_n$ are defined as original variable indexes and $F_1, F_2, \cdots, F_m (m \leq n)$ are defined as new variable indexes. By using the n vectors $X_1, X_2, \cdots, X_n$ of data matrix to make a linear combination, then we can get:

$$\begin{cases} F_1 = a_{11}X_1 + a_{12}X_2 + \cdots + a_{1n}X_n \\ F_2 = a_{21}X_1 + a_{22}X_2 + \cdots + a_{2n}X_n \\ \qquad\qquad \cdots \qquad \cdots \\ F_m = a_{m1}X_1 + a_{m2}X_2 + \cdots + a_{mn}X_n \end{cases} \quad (2)$$

Coefficient a_{ij} meets:

- F_i is linearly independent with $F_j (i \neq j; i, j = 1, 2, \cdots, n)$;
- F_1 has the greatest variance of the linear combination of $X_1, X_2, \cdots, X_n$ mentioned above. F_2 has the greatest variance of the linear combination of $X_1, X_2, \cdots, X_n$ which are independent with F_1. The rest could be deduced in this way. F_m has the greatest variance of the linear combination of $X_1, X_2, \cdots, X_n$ which are independent with $F_1, F_2, \cdots, F_{m-1} (m \leq n)$.

New variable indexes $F_1, F_2, \cdots, F_m (m \leq n)$ are called the first, second, $\cdots$, m^{th} principal component respectively.

2.2 Data Envelopment Analysis

Based on the relative efficiency concept, the data envelopment analysis is a non-parametric statistical method employing convex analysis and linear programming as tools to calculate the relative efficiency between the same type of multi-input and multi-output decision making units. The relative efficiency is used to evaluate whether the decision-making unit is effective.

(1) CCR Mode
Assume that there are n decision-making units (hereinafter referred to as DMU), each DMU has n inputs and m outputs. The input vector of DMU_j is $X_j = (x_{1j}, x_{2j}, \cdots, x_{mj})^T \geq 0, X_j \in R^+$ while output vector is $Y_j = (y_{1j}, y_{2j}, \cdots, y_{sj})^T \geq 0, Y_j \in R^+$ Building a model with a non-Archimedes infinitely small to evaluate the relative efficiency of the DMU$_j$:

$$\min\left[\,\theta - \varepsilon(e_1^T s^- + e_2^T s^+)\right]$$
$$s.t.\ \begin{cases} \sum\limits_{j=1}^{n} \lambda_j x_j + s^- = \theta x_0 \\ \sum\limits_{j=1}^{n} \lambda_j y_j - s^+ = y_0 \\ \lambda_j \geq 0, j = 1, 2, \cdots, n \\ s^+ \geq 0, s^- \geq 0 \end{cases} \tag{3}$$

ε is non-Archimedes infinitely small. s^- is the slack variable while s^+ is the remaining variable. Assuming that Eq. (3) has the best solution $\theta_0, \lambda_0, s_0^-, s_0^+$ for DMU$_{j0}$. If $\theta_0 < 1$, DMU$_{j0}$ will be non-DEA effective. If $\theta_0 = 1$ and s_0^- or $s_0^+ \neq 0$, DMU$_{j0}$ will be weakly DEA effective. If $\theta_0 = 1$ and DMU$_{j0}$ will be DEA effective.

(2) BCC Model
BCC model is the extension of fixed scale benefit data envelopment analysis. Adding the convexity condition $\sum_{j=1}^{n} \lambda_j = 1$ to the linear programming under fixed scale benefit model (CCR model) is the BCC model:

$$\min\left[\,\theta - \varepsilon(e_1^T s^- + e_2^T s^+)\right]$$
$$s.t.\ \begin{cases} \sum\limits_{j=1}^{n} \lambda_j x_j + s^- = \theta x_0 \\ \sum\limits_{j=1}^{n} \lambda_j y_j - s^+ = y_0 \\ \sum\limits_{j=1}^{n} \lambda_j = 1 \\ \lambda_j \geq 0, j = 1, 2, \cdots, n \\ s^+ \geq 0, s^- \geq 0. \end{cases} \tag{4}$$

3 The Process of E-Government Efficiency Evaluation

3.1 Samples, Indexes and Data Collection

The decision-making units in DEA should have the same type of characteristics. In order to evaluate the relative effectiveness of e-government at the county level in Sichuan Province, this paper selects the 147 districts and counties (including county level cities) in Sichuan Province as the objects of the research.

In accordance with the requirements of the DEA method, we need to establish an index system of input and output based on the comprehensive consideration of region informatization level, economic development, cultural and educational level and other factors. There are nine categories of input indexes in this paper which specifically include fixed telephone subscribers, the number of mobile phone users, the value of the tertiary industry income, GDP, total fiscal revenue, governmental investment in science and education, the proportion of urban population, the number of students in colleges and universities, the number of colleges and universities. These index data are mainly obtained from "Sichuan Province Statistical Yearbook" (2014) [16] and "The Statistics Bulletin of the National Economy and Social Development" (2013) issued by the various districts and counties (including county level cities).

To select proper output indicators, we referenced the objective indexes derived from CCID consulting assessment of government website performance and The United Nations for the global objective of e-government assessment. This study revolves around the authoritative evaluation results to screen the indexes. The five main evaluation indexes consist of government information publicity, work services, public participation, the website management, application of new technology. Output index data are mainly obtained from "The total Report of the Sichuan Government Website Performance Evaluation" (2013) [6].

3.2 Principal Component Analysis

The principal component analysis of 9 input indexes and 5 output indexes data were conducted by SPSS software (Tables 1 and 2).

According to extracts of the principal component to calculate the principal component load, the formula is:

$$l_{ij} = p(z_i, x_j) = \sqrt{\lambda_i} a_{ij} (i = 1, 2, \cdots, k, k \text{ as main composition}, \quad j = 1, 2, \cdots, 147) \tag{5}$$

Then we can get the principal component index data of inputs and outputs.

Table 1. The result of PCA of the input indexes

Principal component analysis	Eigenvalue
$F1$	5.963

Table 2. The result of PCA of the output indexes

Principal component analysis	Eigenvalue
E1	2.469
E2	1.004

Table 3. The results of e-government input and output efficiency evaluation (1)

City or Autonomous prefecture	County	CCR	BCC	Scale efficiency
Chengdu City	Jinjiang District	0.919	1	0.919
	Qingyang District	0.581	0.581	0.999
	Jinniu District	0.557	0.582	0.957
	Wuhou District	1	1	1
	Chenghua District	0.832	0.995	0.836
	Longquanyi District	0.627	0.627	0.999
	Qingbaijiang District	0.226	0.226	1
	Xindu District	0.583	0.868	0.672
	Wenjiang District	0.464	0.465	0.999
	Dujiangyan City	0.318	0.318	0.998
	Pengzhou City	0.261	0.262	0.999
	Qionglai City	0.17	0.17	0.999
	Chongzhou City	0.193	0.385	0.5
	Jintang County	0.18	0.18	0.999
	Shuangliu County	0.673	0.673	1
	Pixian County	0.587	1	0.587
	Dayi County	0.185	0.187	0.991
	Pujiang County	0.226	0.226	0.999
	Xinjin County	0.318	0.77	0.413
Guangan City	Guangan District	0.201	0.202	0.998
	Linshui County	0.179	0.18	0.995
	Wusheng County	0.157	0.158	0.996
	Yuechi County	0.158	1	0.158
	Huayun City	0.139	0.14	0.997
Bazhong City	Bazhou District	0.185	0.185	1
	Pingchang County	0.153	0.153	0.996
	Tongjiang County	0.144	0.144	0.997
	Nanjiang County	0.175	0.175	0.998
Meishan City	Dongpo District	0.257	0.258	0.999
	Pengshan District	0.138	0.218	0.633
	Renshou County	0.221	0.221	0.998
	Qingshen County	0.088	0.113	0.777
	Hongya County	0.092	0.1	0.922

(*Continued*)

Table 3. (*Continued*)

City or Autonomous prefecture	County	CCR	BCC	Scale efficiency
Tibetan Autonomous Prefecture of Garze	Kangding County	0.199	0.212	0.936
	Luding County	0.146	0.213	0.686
	Jiulong County	0.117	0.218	0.537
	Dawu County	0.088	0.159	0.551
	Litang County	0.095	0.152	0.622
	Daocheng County	0.132	0.26	0.507
	Yajiang County	0.104	0.204	0.511
Liangshan Autonomous Prefecture	Xichang City	0.341	0.342	0.998
	Dechang County	0.116	0.146	0.793
	Huili County	0.162	0.162	0.999
	Huidong County	0.12	0.137	0.876
	Ningnan County	0.123	0.151	0.817
	Jinyang County	0.077	0.145	0.529
	Butuo County	0.083	0.16	0.516
	Zhaojue County	0.096	0.159	0.599
	Leibo County	0.124	0.18	0.689
	Ganluo County	0.105	0.181	0.582
	Yuexi County	0.098	0.148	0.666

On account of that the result of the principal component analysis is negative number, and DEA model requires that the data is not negative, so the results of the principal component calculated by poor transformation normalized to [1, 10] interval. The range transform formula is:

$$n_{\text{new}} = 1 + 9 \times [(n - n_{\min})/(n_{\max} - n_{\min})], \tag{6}$$

where $n_{\max}$ and $n_{\min}$ represent the maximum and minimum values of the column data respectively (Tables 3 and 4).

3.3 The Solution of the DEA Model

According to the principal component analysis method, the main components of input and output index data are obtained. After that, we use the DEAP 2.1 to solve 147 counties' (including districts' and cities') input-output efficiency of e-government with CCR and BCC model, and we obtain the comprehensive efficiency, pure technical efficiency and scale efficiency of all counties' (including districts' and cities') e-government. All results are shown in Table 5.

Table 4. The results of e-government input and output efficiency evaluation (2)

City or Autonomous prefecture	County	*CCR*	*BCC*	Scale efficiency
Yibin City	Cuiping District	0.386	0.387	0.999
	Nanxi District	0.166	0.19	0.874
	Yibin County	0.184	0.185	0.995
	Jiang'an County	0.153	0.154	0.995
	Gongxian County	1	1	1
	Junlian County	0.151	0.168	0.903
	Xingwen County	0.159	0.164	0.967
	Pingshan County	0.106	0.161	0.659
Ya'anCity	Yucheng District	0.423	0.424	0.998
	Hanyuan County	0.171	0.145	0.848
	Shimian County	0.117	0.151	0.774
	Lushan County	0.114	0.152	0.747
Nanchong City	Shunqing District	0.346	0.347	0.999
	Gaoping District	0.134	0.134	0.998
	Xichong County	0.124	0.124	0.996
	Nanbu County	0.16	0.161	0.998
	Yilong County	0.141	0.142	0.998
	Yingshan County	0.147	0.148	0.995
	Peng'an County	0.107	0.108	0.998
Luzhou City	Jiangyang District	0.282	0.283	0.998
	Naxi District	0.261	0.262	0.999
	Luxian County	0.216	0.217	0.998
	Gulin County	0.137	0.137	0.998
Dazhou City	Tongchuan District	0.277	0.278	0.998
	Dachuan District	0.234	0.234	1
	Xuanhan County	0.267	0.267	1
	Kaijiang County	0.166	0.171	0.969
	Dazhu County	0.276	0.277	0.996
	Quxian County	0.25	0.251	0.997
	Wanyuan City	0.196	0.409	0.48
Aba Tibetan and Qiang Autonomous Prefecture	Maerkang County	0.171	0.189	0.903
	Jinchuan County	0.089	0.151	0.594
	Xiaojin County	0.152	0.181	0.841
	Aba County	0.088	0.161	0.55
	Ruoergai County	0.101	0.132	0.771

(*Continued*)

Table 4. (*Continued*)

City or Autonomous prefecture	County	*CCR*	*BCC*	Scale efficiency
	Hongyuan County	0.128	0.218	0.587
	Rangtang County	0.085	0.175	0.485
	Wenchuan County	0.124	0.145	0.858
	Lixian County	0.096	0.159	0.599
	Maoxian County	0.108	0.147	0.735
	Songpan County	0.114	0.177	0.645
	Jiuzhaigou County	0.103	0.133	0.775
	Heishui County	0.095	0.163	0.585
Guangyuan City	Lizhou District	0.248	0.249	1
	Zhaohua District	0.128	0.271	0.473
	Chaotian District	0.089	0.115	0.777
	Wangcang Distric	0.18	0.183	0.98
	Qingchuan County	0.17	0.232	0.732
	Jiange County	0.19	0.196	0.967
	Cangxi County	0.191	0.192	0.996

Table 5. The results of e-government input and output efficiency evaluation (3)

City or Autonomous Prefecture	County	CCR	BCC	Scale efficiency
Suining City	Chuanshan District	0.26	0.26	0.997
	Anju District	0.127	0.146	0.871
	Shehong County	0.181	0.209	0.867
	Pengxi County	0.109	0.114	0.957
	Daying County	0.121	0.134	0.905
Neijiang City	Central District	0.353	0.58	0.609
	Dongxing District	0.27	0.319	0.846
	Zizhong County	0.216	0.367	0.588
	Longchang County	0.245	0.302	0.81
	Weiyuan County	0.211	0.407	0.518
Leshan City	Central District	0.399	0.4	0.998
	Shawan District	0.18	0.191	0.943
	Wutongqiao District	0.154	0.154	0.998
	Jinkouhe District	0.102	0.152	0.67
	Qianwei County	0.186	0.187	0.997

(*Continued*)

Table 5. (*Continued*)

City or Autonomous Prefecture	County	CCR	BCC	Scale efficiency
	Jingyan County	0.122	0.145	0.839
	Jiajiang County	0.153	0.153	0.997
	Muchuan County	0.129	0.175	0.733
	Emeishan City	0.261	0.262	0.999
	Ebian Yi Autonomous County	0.1	0.148	0.674
	Mabian Yi Autonomous County	0.107	0.162	0.664
Ziyang City	Yanjiang District	0.206	0.207	0.998
	Jianyang City	0.236	0.236	0.998
Mianyang City	Fucheng District	0.554	0.555	1
	Youxian District	0.219	0.219	0.998
	Zitong County	0.12	0.141	0.85
	Santai County	0.204	0.204	0.998
	Yanting County	0.195	0.201	0.969
	Anxian County	0.133	0.14	0.954
	Pingwu County	0.145	0.156	0.93
	Jiangyou City	0.261	0.262	0.998
	Beichuan Qiang Autonomous Region	0.106	0.14	0.756
Zigong City	Ziliujing District	0.368	0.369	0.997
	Yantan District	0.168	0.198	0.849
	Fushun County	0.224	0.225	0.996
Panzhihua City	East District	0.396	0.402	0.984
	West District	0.227	0.564	0.403
	RenHe district	0.127	0.138	0.92
	Miyi County	0.14	0.159	0.883
	Yanbian County	0.199	0.23	0.864
Deyang City	Jingyang District	0.312	0.312	0.998
	Guanghan City	0.205	0.205	0.998
	Shifang City	0.19	0.191	0.998
	Mianzhu City	0.169	0.17	0.996
	Zhongjiang County	0.184	0.185	0.998
	Luoyang County	0.124	0.134	0.92

4 Analysis of the Result

Through the analysis of *CCR*, it appears that Wuhou District in Chengdu and Gongxian County in Yibin have achieved a full effectiveness of comprehensive efficiency (CCR = 1.000) among 147 counties, districts, or cities of Sichuan Province, which indicates that they have obtained a fully efficient outcome. However, two districts, Jinjiang and Chenghua in Chengdu, are in the position of a light level of non-DEA effective degree ($0.700 \leq \text{CCR} < 1.000$). For those of a light level of non-effective degree, the development of electronic administration requires focusing more on the control and management of details and proper distribution of the investment, as there's still some room for improvement. Meanwhile, most of counties (including districts and cities) are in a severe level of non-DEA effective degree ($\text{CCR} \leq 0.500$), which suggests that most counties' e-government development in Sichuan province don't work out. The overall development gap is huge, and most of objects have not achieved the comprehensive effectiveness. The input of the e-government construction has not acquired the desired results. On the one hand, the technical inefficiency leads to the comprehensive ineffectiveness. On the other hand, the low scale efficiency also affects the improvement of the comprehensive efficiency. Therefore, the government should make a huge effort to find out the route to suit the situation, so as to surmount the problem fundamentally. The counties and districts with the lowest CCR, Jinyang County and Butuo County in Liangshan, Rangtang County in Tibetan Qiang Autonomous Prefecture of Aba, Qingshen county in Meishan, Dawu County in Tibetan Autonomous Prefecture of Garze, Aba County in Aba Tibetan and Qiang Autonomous Prefecture, correspond to their relatively weak national economy and social development, as well as the influence of little capital invested by the government on information construction. Thus, problems should be solved and development should be sped up in the future construction of e-government.

The pure technical efficiency results obtained by the BCC model show that Jinjiang district, Wuhou District and Pixian County of Chengdu are with pure technical effective (BCC = 1.00). It indicates that their services systems of e-government run well, and the resources invested can develop productivity efficiently. The pure technical efficiency of 132 counties, districts or cities are lower than 0.5, and it appears that these local governments' technical outcomes are not enough. The last 5 counties, districts or cities with the lowest BCC successively are Hongya County in Meishan, Peng'an County in Nanchong, Qingshen County in Meishan, Pengxi County in Suining, Chaotian District in Guangyuan. It indicates these governments didn't distribute the resources legitimately, and they need more technological innovation to improve the service abilities of e-government from technology level.

From the point of view of scale efficiency, there are 9 counties or districts of Sichuan Province in full scale efficiency. They are Wuhou District, Qingbaijiang District and Shuangliu County in Chengdu, Gongxian County in Yibin, Dachuan District and Xuanhan District in Dazhou, Fucheng District in Mianyang, Lizhou District in Guangyuan and Bazhou District in Bazhong.

These governments input resources in e-government are proper, and returns of scale remain unchanged. The rest 138 counties, districts or cities are not in full scale efficiency, it manifests that these governments waste some resources during the construction of e-government. In the future, the governments need to increase the investment in information technology and science and education, for speeding up the process of urbanization and informatization. What's more, the governments should allocate resources more reasonably to improve the level of government information disclosure, services and websites management. Besides, governments should make more and more people participate in the construction of e-government in order to take better use of the resources.

5 Conclusions

Due to the wave of the informatization and popularization of the network, the construction of e-government in the human condition is getting better and better. Governments at all levels are also vigorously investing money and human resources for the construction of e-government to promote the informatization. To guide the construction of e-government, how to accurately evaluate and scientifically observe the efficiency of e-government is a hotspot and difficulty in the field of current e-government. Although there are a lot of foreign standards being references, different countries may have different national conditions. The real effective e-government construction has to be combined with the actual situation. According to the views of scholars and organizations at home and abroad, based on observation and thinking, we use different indexes and principal component analysis and DEA model to evaluate the e-government construction efficiency of all districts and counties of Sichuan Province. We hope to be able to scientifically evaluate the comprehensive efficiency of various districts and counties of Sichuan Province in the construction of e-government. On the whole, the local government's information department should focus on improving their investment scale and technical efficiency to enhance the efficiency of e-government.

However, this paper also has some limitations. Firstly, we take both input and output into consideration which also have been rotated, extracted and standardized. Therefore, this paper couldn't use the projection algorithm to get the improvement solutions which give the target value and scope for the non-DEA effective. Secondly, DEA focus on the relative efficiency. It means that different evaluation range may have different result. So how to choose the evaluation range is a project worth exploring. In later study, we will commence on diminishing the limitations above and optimize the solution.

Acknowledgements. We would like to express our sincere appreciation to the reviewers for their insightful comments, which have greatly aided us improving the quality of the paper. This research was supported by the Soft Science Research Project of Chengdu (Grant 2016-RK00-00041-ZF).

References

1. Accenture (2006) E-government leadership: high performance and maximum value. http://www.accenture.com
2. CCCT (2015) General report on performance evaluation of Chinese government website in 2015. http://ccct.mofcom.gov.cn/article/zt_jxpg2015
3. Commission E (2006) i2010–a European information society for growth and employment. http://www.docin.com/p-28146066.html
4. CSTC (2013) 2013 Chinese government website performance evaluation index system. http://www.cstc.org.cn/templet/default/show_nbkw.jsp?article_id=123668&id=1619
5. CSTC (2015) 2015 Chinese government website performance evaluation results. http://www.ccidnet.com/2015/1209/10063631.shtml
6. CSTC SPegnoc (2014) The total report of the Sichuan government website performance evaluation 2014
7. Guo X, Zou J (2015) A summary of the current situation and pattern of e-government development in China's rural areas. E-Government 1:90–96 (in Chinese)
8. Kao C (2015) Evaluation and improvement of e-government: the case of European countries. In: International conference on E-democracy & E-government, pp 1211–1216
9. Luna DE et al (2010) Using data envelopment analysis (DEA) to assess government web portals performance. In: Proceedings of the 13th annual international conference on digital government research, pp 107–115
10. Luo D, Shi Y (2010) Evaluation on e-government websites based on rough set and genetic neural network algorithm. In: Proceedings of the third international symposium on computer science and computational technology, pp 124–128
11. Nations U (2014) United nations e-government survey 2014: E-government for the future we want
12. Research C (2004) Description of government website evaluation index system. http://dc.ccw.com.cn
13. Rorissa A, Demissie D, Pardo T (2011) Benchmarking e-government: a comparison of frameworks for computing e-government index and ranking. Gov Inf Q 28:354–362 (in English)
14. Song M, Guan Y (2014) The electronic government performance of environmental protection administrations in Anhui province. Technol Forecast Soc Change 96:79–88 (in Chinese)
15. Song M, Guan Y (2015) Measuring e-government performance of provincial government website in China with slacks-based efficiency measurement. Technol Forecast Soc Change 39:25–31 (in Chinese)
16. Sichuan Provincial Bureau of Statistics SPB (2014) Sichuan province statistical yearbook 2014
17. Zdjelar R (2013) Measuring success of implementation county development strategy by using balanced scorecard method. In: International convention on information & communication technology electronics & microelectronics, pp 1211–1216