Evaluation of Proactive Disclosure of Government Information Based on Fuzzy Measure

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ABSTRACT: *In this paper, we design the attribute system based on the "Regulations on the Disclosure of Government Information" and relevant policies. Then we score the proactive information disclosure websites according to the displaying factors, and finally we use the entropy method to calculate the weight of each attribute and the evaluation value of each website to assess the ability of their proactive information disclosure, moreover, we use the fuzzy measure to define an index showing the balance of the development degree. In the case analysis, we select a certain province composed of 15 cities in the eastern part of China as the empirical study. The empirical study shows that the entropy method is meaningful and practical for the evaluation of proactive disclosure of government information in its infancy.*

1. Introduction

The "Regulation of China on the Disclosure of Government Information" was formally promulgated and came into force on May 1, 2008, which has brought great changes both in China s public attitudes and the system of social organization [1]. With the development of information technology and the arrival of mobile Internet Era, the buildup of government websites has become an important way of information disclosure. Furthermore, it has been the most effective way of protecting the right of citizens in modern society. China has launched the "Government Online Project" since 1999 and the penetration rate of China s government website construction has increased year by year. According to the National Information Center, 100% of the State Council and provincial government departments, more than 99.1% of cities and 85% of regional government websites have been built [2]. However, the quality of these websites are not satisfying. According to the "Impact Assessment report of China s government websites in 2013", the influence index of China's government websites was 50.90 points (out of 100), indicating that the level of Chinese government website information disclosure is still in low level. In order to enhance the disclosure ability of government information website, the government must identify those serious flaws which have caused the disadvantage of government website. The most effective way to solve this problem is to further enhance the ability of the proactive disclosure of government information.

On the issue of the establishment of evaluation system of government information disclosure, most scholars focused on the content [3], service [4] or management [5] aspect to make a comprehensive analysis and strived to establish a complete index system. Although this system may make the evaluation results more comprehensive or persuasive to some extent, it has too many attributes and it will weaken the importance of the value of open information itself, which is the essence of open government information. The second weakness is about the weights for the index set. Many scholars often used subjective method, such as Delphi [3], AHP [6, 7], etc. These methods are greatly influenced by subjectivity. Furthermore, it does not reflect the actual situation of the complex assessment of the object. As far as we know, there is no research for the evaluation of the current government information disclosure using information entropy.

The evaluation method of the ability of government information disclosure proposed in this paper is based on the comprehensive analysis of the "Regulations on Open Government Information" and relevant amendment after the implementation of corrective measures. First we construct a series of performance attributes of proactively disclosed information by government. Second, we use the entropy method to evaluate the index weights. And finally we solve the assessed value of the capabilities of government information proactively disclosed. The method is strongly practical for the current situation of China's government information disclosure, and it is easy to understand. Furthermore this method provides a good way to identify the vulnerable targets which need to be improved. Therefore, it provides a brand-new thinking to the evaluation of government's proactive information disclosure and is of great importance for the design of the overall evaluation system of government information disclosure.

2. The Basis For Assessment of the Proactive Disclosure Of Government Information

Proactive disclosure of government information refers to the administrative body's positive open manner on the non-specific behavior program which is based on the mandatory provisions of legal norms [8]. Improving the quality of information disclosure requires the government to increase the amount of open information and to initiate from the perspective of servicing people. The aim is to make the disclosure of government information accessible, available, understandable and free of charge and timely updated [9]. Therefore proactive disclosure of government information should ensure the amount of the disclosed information, but also meet the needs of the serving body while avoiding the openness of excerpts-style [10].

The tenth rules of "Regulations on Open Government Information" clearly stipulates the eleven specific contents which should be the focus of the disclosure of government information, for all the governments above the county level and their related departments. The State Council issued many rules and administrative measures to reform the regulation on open information, such as the "To reform the work of open government information by requested" in January 2010, "Further strengthen the management of government websites" in April 2011 and "The yearly key work's arrangements of open government information" issued in the year 2012 and 2013. All these new rules and regulations emphasize on the disclosure of important government information including administrative examination and approval, government expenses, affordable housing, food safety, production safety, environmental protection etc.

3. The Assessment Methods of the Proactive Disclosure Of Government Information Based on Entropy Method

Entropy is a function of the material used to describe the state of the system, the famous German physicist Rudolf Julius Emanuel Clauses first proposed the concept of entropy in 1850. Initially, the thermodynamic entropy is widely used in theory, to describe the process of thermal motion . By comparing the size of the movement and the entropy of molecules, the entropy can be understood as a measure of the disorder of the internal system. This makes it possible to break through areas thermodynamic entropy, and be applied to other areas. Claude Elwood Shannon first introduced the concept of entropy in information theory, in the evaluation of socio-economic indicators, the degree of indicators distribution and its information entropy value is negatively correlated, so the entropy is a measure to value the degree of balance of indicators.

3.1 Construction of the Evaluation Index
Based on the above ordinances and opinions, the evaluation index of proactive disclosure of government information system is the evaluation process for the open government information contained in the directory of government information disclosure openness website. According to the requirements of the "Regulation"–be comprehensive, timely and accurate, and with reference to the definition of the displaying factors among government information disclosure factors raised by Wu [11], we assess the integrity, timeliness, normalization and functionality of the proactive open government information. Especially we focus on the quality and usability. The aim is to reflect the degree of attention Government has placed on and the status quo of government information disclosure in this area.

3.2 Construction of the Evaluation Matrix

Step 1 Select the proactive disclosure of government information evaluation alternative set U, the number of alternative members is n, which is often bigger than 10.

Step 2 Evaluate the attributes of each alternative and get the evaluation set B, the number of attributes is m. The factors of attributes can be classified into several levels to measure the performance of the factors. Because the factors vary from different attributes, the level can also differ from each factors.

Step 3 Based on the evaluation set of each alternative member, we can build the evaluation matrix P,

$$P = \begin{pmatrix} p_{11} & \cdots & p_{1n} \\ \vdots & \ddots & \vdots \\ p_{m1} & \cdots & p_{mn} \end{pmatrix}.$$
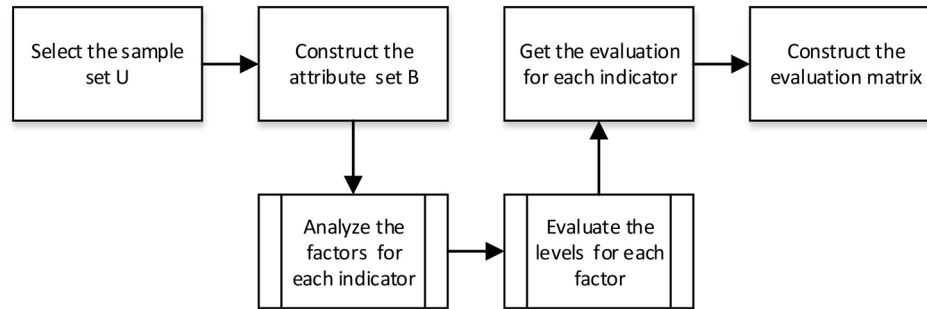
The flow can be described as Fig 1.

Figure 1. The flow of the method to build the evaluation matrix

3.3 Using Entropy Method to Determine the Index Weights

As for an attribute for the evaluation matrix B, the greater the gap between the same attribute from other alternative, then the greater the impact of the attribute in the comprehensive evaluation. Conversely, the attribute plays a relatively small role if its supporting degree for the same index of each alternative are equal. From the aspect of the proactive disclosure of government information, if the degree of the disclosure of the same type of information varies slightly by each government, then the weight of this information value should be small. However, some specific information stipulated in the "Regulation", if the quality gap between the disclosures of each government is large, this attribute should occupy a large percentage in the evaluation.

In an information system, information entropy is a measure of the degree of information disorder. The higher the entropy value, the higher the degree of disorder of information and the smaller the utility value of information. On the contrary, the lower the value of information entropy, the smaller the degree of disorder of the information and the utility value of information will be greater. Information entropy stands for the order degree of a system, the higher the entropy value, the weight of the attribute should be greater. Therefore we can use the entropy method to evaluate each weight of the attributes. The method can be used as the following steps:

1) Calculate the proportion of the jth index of i.

$$p_{ij} = \frac{x_{ij}}{\sum\limits_{i=1}^{m} x_{ij}} \tag{1}$$

2) Calculate the entropy value of the attribute j.

$$e_j = -k \sum\limits_{i=1}^{m} p_{ij} \ln p_{ij} \tag{2}$$

Presume $k > 0$, In stands for natural logarithm and $e_j \geq 0$. It is easy to know that for specific x_{ij}, if j is all the same , then

$$p_{ij} = \frac{x_{ij}}{\sum\limits_{i=1}^{m} x_{ij}} = \frac{1}{m}, \text{ and } e_j = -k \sum\limits_{i=1}^{m} \frac{1}{m} \ln \frac{1}{m} = k \ln m$$ e_j get the max value. For convenient purpose, we can let the $1 \geq e_j \geq 0$, so $k = \frac{1}{\ln m}$

3) Calculate The Difference Coefficient of the Attribute j

For the given j, the smaller the difference between x_{ij}, the e_j will be grater and if x_{ij} has the same value, $e_j = e_{max} = 1$. Then the attribute j is useless for evaluation of different alternative. On the contrary, if the more the gap between the same attribute from different alternative, the smaller the value e_j, and the greater role played by this attribute. We can calculate the difference factor g_j

$$g_j = 1 - e_j \tag{3}$$

The bigger the g_j, the attribute j will be more important.

4) Calculate the Weight of Attribute j

$$w_j = \frac{g_j}{\sum\limits_{i=1}^{n} g_j} \tag{4}$$

Based on the above attributes score obtained in step with the index weight, we can obtain a comprehensive evaluation value R_i of the proactive open capacity of alternative government.

$$R_i = \sum\limits_{j=1}^{m} w_j p_{ij} \tag{5}$$

3.4 Define the Development Balance Index
Measurement is a fundamental concept in mathematics, is the measure like length for the line, the area for plane figures and the volume for containers. In 1974, first proposed by Japanese scholar Sugeno, using weak monotonicity instead of a class of additive set functions, called fuzzy measure. The main features of non-additive fuzzy measures, therefore, also known as non-additive measures.

Let X be a finite set, $P(X)$ is the set of X and all subsets, the set functions $\mu : P(X) \rightarrow [0,1]$ satisfy the following two conditions:

（1）$\mu(\varnothing) = 0$，$\mu(X) = 1$

（2）$E \in P(X)$，$F \in P(X)$，$E \subset F$，then $\mu(E) \leq \mu(F)$

And the μ is defined the regular fuzzy measure in the $P(X)$.

g_j is the variation coefficient of each index. This can be seen as indicators of the degree of importance in the evaluation process, and thus g_j satisfy the regular fuzzy measure, it is interpreted as all indicators is 1 , the degree of importance of each indicator alone is not greater than the degree of importance of the indicators included in the index set.

μ satisfy the λ rule is that existing $\lambda \in \left(-\frac{1}{\sup \mu}, \infty \right)$, makes all the finite disjoint sequence $\{E_1, ..., E_n\}$ of fuzzy numbers F, satisfy

$$\mu\left(\bigcup\limits_{i=1}^{n} E_i \right) = \begin{cases} \dfrac{1}{\lambda} \left\{ \prod\limits_{i=1}^{n} [1 + \lambda \mu(E_i)] - 1 \right\} & \lambda \neq 0 \\ \sum\limits_{i=1}^{n} \mu(E_i) & \lambda = 0 \end{cases}$$

If $g_\lambda(X) = 1$, and any $E \in F$ satisfy $g_\lambda(E) \in [0,1]$, then call it the regular g_λ fuzzy measure, also the Sugeno measure. The λ of the g_λ fuzzy measure is calculated as

$$\prod_{i=1}^{n}(1+\lambda\,g_i)=1+\lambda \qquad\qquad (6)$$

In the evaluation process, we will use the extent of the difference as an important factor index, calculate the λ value of the coefficient g_j, to indicate that the balance index of the evaluation sample set. $1 \geq g_j \geq 0$ so $\lambda \in (-1,\infty)$, when $g_j \to 1$, the coefficient of variation is max, so $\lambda \to -1$. when all the $g_j = 0$, there is no difference between the index $\lambda \to \infty$, So it can be seen as a sample of the overall balance index.

4. An Empirical Study of Open Government Information

In this case, we select a certain province composed of 15 cities in the eastern part of China, and each city has its government information disclosure website. We use the assess method to calculate and measure the proactive disclosure capacity over these 15 cities' websites. According to the "Regulation" and relevant rectification opinions, the index system contains a total of 10 main attributes. They are: F1: Administrative rules, regulations and normative documents; F2: National Economic and Social Development Statistics; F3: Budgets and final reports; F4: Administrative fees of the project, according to standard; F5: Catalog of government procurement projects, standards and implementation; F6: Administrative approval information; F7: Ratification and implementation of major construction projects; F8: Social protection policies and measures poverty alleviation, health care, etc.; F9: Public emergency contingency plans, early warning information; F10: Environmental protection, Production safety, food and drug safety supervision and inspection; These attributes were measured for their completeness, timeliness, normalization and functionality, these four factors. Integrity Index includes the amount of information, drafting specifications and layout settings; Timeliness includes comparing the time of information generated with the time information published and the time of information published with the current time. Normalization includes classification settings, time settings, and the index settings; Functionality includes interface design and the measurement of the convenient of information on the various attributes. The factors for evaluation are displayed in Table 1.

Factors Level 1	completeness			timeliness		normative			functional
Factors Level 2	Amount	Draft	Layout	Published	Current	Classify	Index	Date	convenient

Table 1. The factors for evaluation

4.1 Construct the Evaluation Set of Proactive Open Government Information
In the 15 cities cases of 3 years, in accordance with the above-mentioned attributes and measurement criteria of a city government proactive open information website, inviting experts to score the 10 attributes of 15 cities, we can construct the evaluation matrix of proactive disclosure of government information website, showing in Table 2 (2012 for example).

4.2 Calculate the Weight of Attributes and Evaluation Results
According to Table 2, we can calculate the entropy value e_j from (2), such as attribute 1, $j = 1$, then according to (1)

$$p_{11}=\frac{x_{ij}}{\sum\limits_{i=1}^{m}x_{ij}}=\frac{x_{11}}{\sum\limits_{i=1}^{15}x_{i1}}=0.088$$

We can get the $p_{(2\sim15)1}$, as shown in Table 3. Then,

$$e_1 = -k\sum_{i=1}^{m} p_{ij}\ln p_{ij}$$
$$= -\frac{1}{\ln m}\sum_{i=1}^{m} p_{ij}\ln p_{ij}$$
$$= -\frac{1}{\ln 15}(\sum_{i=1}^{15} p_{i1}\ln p_{i1}) = 0.993\,,$$

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
C_1	1	0.1	0.85	0.1	0.85	0.7	0.65	1	0.5	1
C_2	0.95	0.625	0.95	0.1	0.95	0.1	0.475	0.45	0.95	0.1
C_3	0.775	1	0.1	0.1	0.1	1	0.1	0.525	0.35	0.9
C_4	0.85	1	0.875	0.75	0.15	0.1	0.1	0.5	0.1	0.1
C_5	0.725	0.1	0.1	0.675	0.875	1	0.1	0.1	0.1	0.45
C_6	0.575	0.8	0.1	0.35	0.1	0.1	1	0.1	0.85	0.1
C_7	0.85	0.45	0.1	0.1	0.5	0.5	0.1	0.1	0.85	0.1
C_8	0.6	1	0.1	0.1	0.675	0.1	0.1	0.1	0.725	0.1
C_9	0.85	0.1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.775
C_{10}	0.725	0.1	0.5	0.1	0.5	0.1	1	0.1	0.1	0.1
C_{11}	0.625	0.1	0.575	0.1	0.9	0.1	0.1	0.1	0.625	0.1
C_{12}	1	0.5	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1
C_{13}	0.55	0.1	0.1	0.1	0.95	0.1	0.1	0.1	0.1	0.1
C_{14}	0.625	0.1	0.1	0.1	0.775	0.1	0.1	0.1	0.1	0.1
C_{15}	0.625	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 2. The evaluation matrix of proactive open of government information website(2012)

We get the $e_{2\sim10}$ shown in Table 4. Thus,

$$g_1 = 1 - e_j$$
$$= 1 - e_1 = 1 - 0.993 = 0.007 \,,$$

We get the $g_{1\sim10}$ as shown in Table 5. According to (4), we can calculate the weight of attributes w_i

$$w_1 = \frac{g_j}{\sum_{i=1}^{n} g_j} = \frac{0.007}{1.416} = 0.005 \,,$$

We get the $w_{2\sim10}$ as shown in Table 6. Finally, we can calculate the evaluation results of 15 cities' government proactive disclosure information website.

$$C_1 = \sum_{j=1}^{m} w_j p_{ij} = \sum_{j=1}^{10} w_j p_{ij} = 0.65 \,,$$

We get the $C_{2\sim15}$ as shown in Table 7.

According to (6), we can calculate disclosure balance of the government information index of 15 cities in 2012, the $\lambda = -0.5745$

P_{11}	P_{21}	P_{31}	P_{41}	P_{51}	P_{61}	P_{71}	P_{81}	P_{91}	$P_{10\,1}$	$P_{11\,1}$	$P_{12\,1}$	$P_{13\,1}$	$P_{14\,1}$	$P_{15\,1}$
0.088	0.084	0.068	0.075	0.064	0.051	0.075	0.053	0.075	0.064	0.055	0.088	0.049	0.055	0.055

Table 3. The proportion of item 1 index

e_1	e_2	e_3	e_4	e_5	e_6	e_7	e_8	e_9	e_{10}
0.993	0.853	0.830	0.851	0.929	0.807	0.809	0.840	0.862	0.810

Table 4. The entropy value of the attribute j

g_1	g_2	g_3	g_4	g_5	g_6	g_7	g_8	g_9	g_{10}
0.007	0.147	0.170	0.149	0.071	0.193	0.191	0.160	0.138	0.190

Table 5. The difference factor of the attribute j

w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}
0.005	0.104	0.120	0.105	0.050	0.136	0.135	0.113	0.097	0.134

Table 6. The weight of attributes j

C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}
0.65	0.48	0.50	0.41	0.37	0.40	0.29	0.29	0.24	0.29	0.25	0.19	0.14	0.14	0.10

Table 7. Evaluation value of the proactive open capacity

4.3 Result analysis

4.3.1 Analysis for Entropy Weight - Average Weight and the balance index

We calculate the entropy weight and the balance index of these 15 cities in the province in three consecutive years by above method, and we also calculate the average weight of each indicator to show the level of development in the three years.
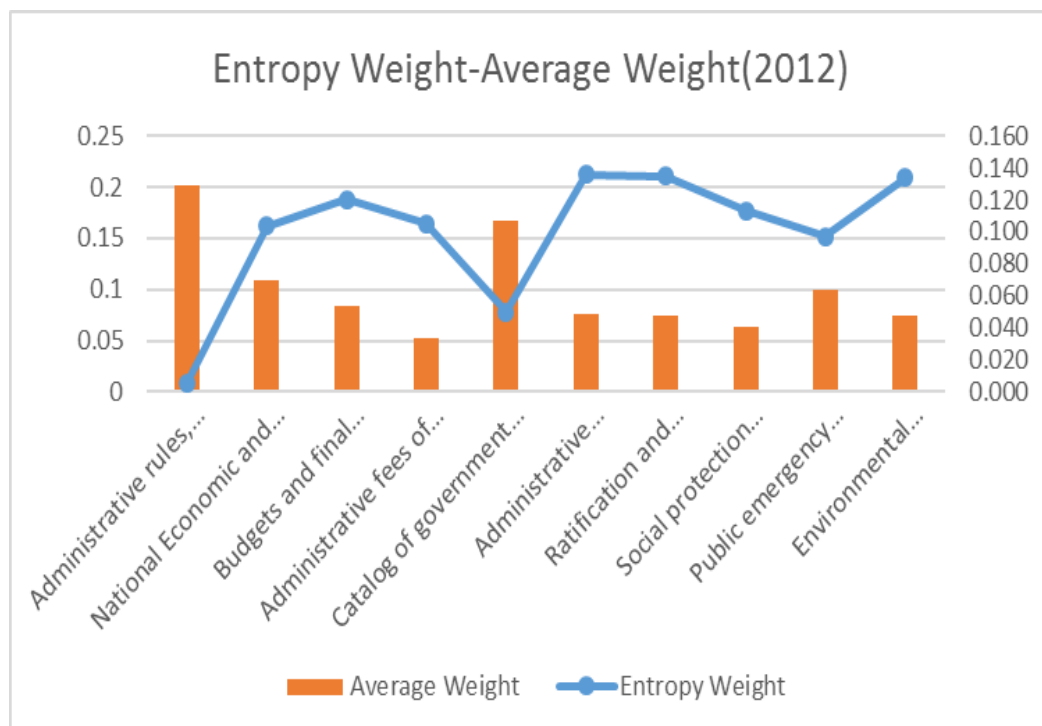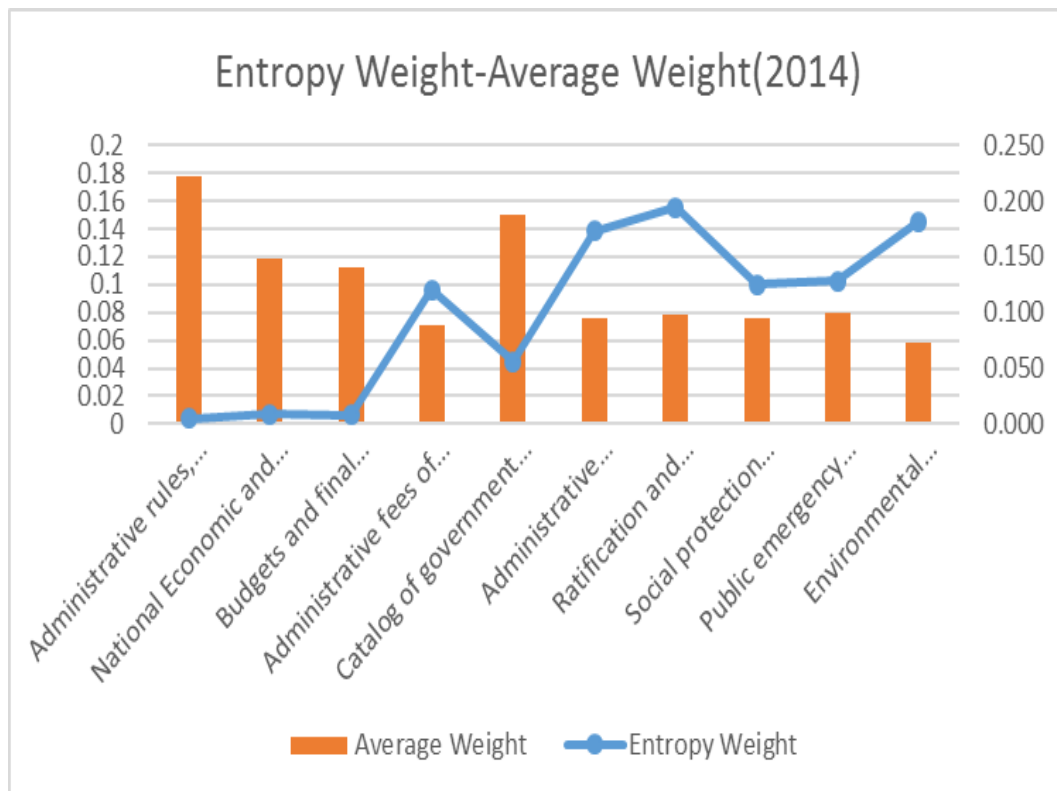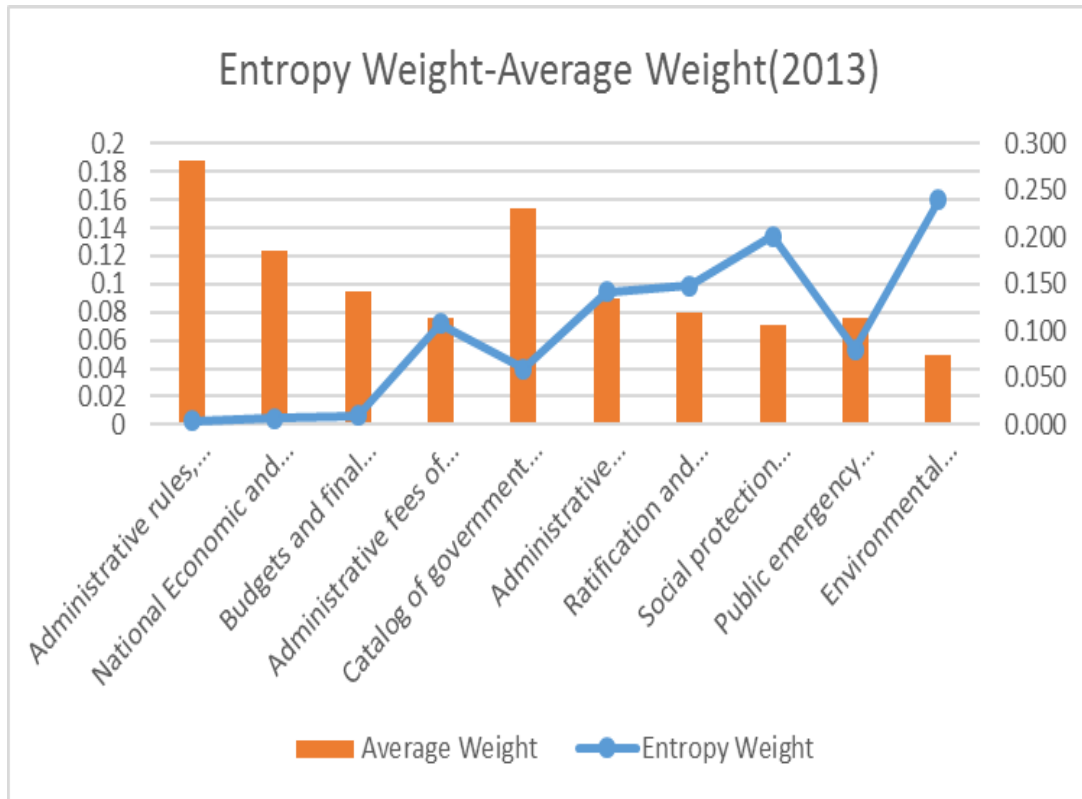
Figure 2. The entropy weight and average weight(2012-2014)

We can analyse form the above three Figs that:

(1) F_1 and F_5 has higher average weight and lower entropy weight, illustrates that the development of these two indicators are evenly, and has better condition for disclosure. The reason is that administrative regulations, public directories and other basic normative documents are forwarded by the higher authorities, the workload required for smaller and has less controversial, so the public enthusiasm is higher.

(2) The score of F_2 and F_3 of 2013 and 2014 is apparently better than them in 2012, the average weight is growing bigger and the entropy weight is smaller, illustrates these two indicators have improved significantly in these cities , and the difference is reduced around, the reasons is that the disclosure regulations supplementary report repeatedly stressed the year's budget and the National Development Index publicly and the workload of these two required comparatively less, and therefore the level of development tends to faster.

(3) The score of F_4 , F_6 and F_7 have smaller improvement for average weight, as well as the entropy weight, illustrates the overall level of development of these indices have been some progress, but the gap widened further. The reasons are related to the project as well as the license fee is based on standards and other indicators, different levels of attention around the city, and requires high update frequency, also the big work volume, the municipal government for the formation of ground-level workflows can better public relevant information, but the superficial part of the government's public didn't public the same content.

(4) F_8 and F_{10} have the higher entropy weight and the lower average weight, illustrates the lower average level and a large gap between these two indicators . The reasons is that the two indicators has more livelihood content which needs larger workload and requires multi-sectoral joint collaboration, in part, will be assigned to the municipal government level under the charge of the Bureau, but there is a larger gap between the level of each bureau, a small part can ensure regular updates, most updates slowly, even not updated.

(5) F_9 is the indicator that needs lower frequency update, so both average weight and entropy weight changes slow

The entropy method can describe the gap of the proactive disclosure on the same attribute information among these 15 cities. Meanwhile, the average value can describe the average level of each attribute. So if the weight of average value is clearly higher than the weight of entropy value, as well as the light colour part is dominant in Fig2, then the gap between each city is smaller and the average level is higher. On the contrary, if the weight of entropy value is clearly higher than the weight of average value, as well as the dark colour part is dominant in Fig 2, then the average level is lower and the gap between each city is bigger. We can conclude from the Fig 2 that the administrative rules, regulations and normative documents, catalogue of government procurement projects get a high average level but the gap between each city is very small, which shows that most of the government is willing to open these information, and the quality of these open information is high. But when it comes to the information about the administrative fees of the project, social protection policies and measures poverty alleviation, health care, etc. and the environmental protection, production safety, food and drug safety supervision and inspection, the gap of quality among them is very big but the average level is small, which shows that for these types of Government's disclosure activeness is not high.

According to the survey research from the Public Participation and Support Centre of Peking University [12], about "What the public care about from government information disclosure", the information about the social protection policies and measures poverty alleviation, health care, etc. ranked No.1 and the administrative fees of the project ranked No.3 which shows that the public want to get these information from the government because these information is relevant to their life. At the same time, the information about the administrative rules, regulations and normative documents and the catalogue of government procurement projects get a low position which means the public do not care much about these information, they can get little from these information. Our research above and this survey can clearly shows that the evaluation based on entropy weight can easily find out the type of information that government shows less willingness to open and the weakness of the government information disclosure.

4.3.2 Analysis for Balance Index and Result
According to (6) we can calculate the three years' balance index, shown in Table 8.

We can find that the balance index is a bit

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	index
2012	0.007	0.147	0.170	0.149	0.071	0.193	0.191	0.160	0.138	0.190	-0.5746
2013	0.006	0.010	0.014	0.149	0.083	0.196	0.205	0.278	0.111	0.332	-0.5643
2014	0.007	0.012	0.011	0.165	0.077	0.238	0.267	0.172	0.107	0.250	-0.652

Table 8. Balance index from 2012-2014

Balance index has a little increase in 2012 and 2013 years, the reason is that the emphasized public information of 2012 and 2013 by State Department has not much change, so public level of these cities stabilized. The 2014 focus of public information with rich content, the relevant government who has the higher the sensitivity take the lead in focusing public government information, while the government who pay little attention about these information is still stay the original level, even small amplitude decline, leading to a public level between the country-level city opened a gap, which led to decreased the balance index.

From the evaluation value of table 7, if we set the boundary of the level of the quality of the proactive open information by government. Define very good (1.0-0.8), good (0.8-0.6), fair (0.6-0.4), bad (0.4-0.2), very bad (0.2-0), then we can easily get the evaluation period and percentage shown in table 9.

Very good（1-0.8）	Good（0.8-0.6）	Fair（0.6-0.4）	Bad（0.4-0.2）	Very bad（0.2-0）
0	1	4	6	4
0.00%	6.67%	26.67%	40.00%	26.67%

Table 9. Evaluation period and percentage(2012)

From the above table we can find out that there is only 1 city in the boundary of good level, 66.7% below the fair level which proves that government information disclosure over the city level is still in its infancy

5. Conclusion

In this paper, we first design the evaluation system based on the "Regulations on Open Government Information" and relevant improved policies, second we scored 15 cities' government website about the proactive information disclosure according to the integrity, timeliness, normalization and functionality in an eastern province, finally we use the entropy method to calculate each attribute's weight and calculate the evaluation value of each city's website and assess the ability of the proactive information disclosure.

To compare with the most frequently used method of AHP, fuzzy comprehensive evaluation to determine the weight of each attribute, the entropy method can show the weakness of the construction of open government information website at the initial stage. Its major advantage is to point out the attributes whose disclosure gap between different governments are big. And through the analysis with the survey of "What the public care about from government information disclosure", we can conclude that the information that government has little willingness to open is just what the public care about.

There are two discussion flaws in the article. First, the current attribute system of government information disclosure does not form a unified standard, hence, how to reform the evaluation system is a problem. Second, whether the attributes giving the attributes that are difficult to quantify a real score is not appropriate. Therefore, successive research will be done to improve these two flaws.

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