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Science and Technology Service Websites Evaluation and A Case Study

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Abstract: By integrating the existing website evaluation indexes and website evaluation methods, based on the method of principle component analysis, which is a kind of dimension reduction statistics and commonly used to deal with practical problems of multiple indexes, after deeply investigating the domestic and overseas science and technology service websites, 14 indexes are extracted as the evaluation indexes. Then, from the two aspects of quantitative and qualitative analyses, by using the monitoring results, the 158 famous science and technology service websites of China are assessed and sequenced. The science and technology service websites with better evaluation results will be popularized to the whole China.

Key words: Website evaluation, case study, principle component analysis, multiple indexes, assessment

INTRODUCTION

Worldwide web service is one of the core business provide by internet. At present, it has permeated all aspects of our life. The basic components of worldwide web are all sorts of websites. The quality of websites determines the quality of the service for us (Chen and Liao, 2008). As a result, the objective and scientific evaluation of websites will be of great significance to the development of internet. Generally speaking, the object of website evaluation is all sorts of websites, including common information websites and special websites aiming at certain fields. The contents of evaluation include the content, design of websites and the acceptance of the site users and so forth, which is a very abundant research subject.

EVALUATION METHOD OF WEBSITES

From an integrating aspect, the methods of evaluating websites include website tracking statistics (Shen and Li, 2005), software real-time test (Al-Juboori *et al*., 2012), network metering(Liu and Wang, 2004), data digging based on log files (Kayed and Hashem, 2012), business value-driven website evaluation (Hahn and Kauffman, 2005), comprehensive evaluation (systematic engineering) (Huang *et al*., 2003), information construction based evaluation method (Du and Zhu, 2004), e-service quality evaluation (Zeithaml *et al*., 2000), consumption behavior based evaluation (Agosto, 2002), etc. Each evaluation method has its unique science basis and development course and its best appropriate application environment. The appropriate evaluation method shall be selected according to the practical application requirements.

WEBSITE EVALUATION INDEXES

Many scholars and research organizations have put forward website evaluation indexes. Besty Richmond once put forward "10C"indexes of network information resource evaluation (Richmond, 1996), i.e. content, credibility, critical thinking, copyright, citation, continuity, censorship, connectivity, comparability and context. David Stocker and Alison Cooke put forward other 8 standards in Network Information Resources Evaluation: Authority, information source, scope and expounding, text format, information organization approaches, technical elements, price and availability, user support system (David, 1995). Robert Harris put forward 8 standards for network information evaluation: the existence of quality control or not, readers' object and purpose, timeliness, rationality, any doubtful areas, like false statement, etc., objectiveness, world view, quotations. In addition, he also put forward the CARS test system: credibility, accuracy, rationality and supportability (Harris, 2010).

Jim (1998) put forward five evaluation indexes specially aiming at information content in his Five Standards of Webpage Evaluation: accuracy, authority, timeliness, objectiveness and comprehensiveness. Stuart J. Barnes and Richard Vidgen specially adopted a kind of tool called Webqual to measure the quality of websites in their Measuring Web site Quality Improvements, a case study of the forum on strategic management knowledge exchange.

This tool can be used to measure users' evaluation about a website by means of 4 indexes and 20 problems. The representative evaluation indexes put forward by organizations include several typeset as follows: Argus Associate put forward the evaluation indexes including

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website resource description, subjective assessment, design level, institutional framework and resource guidance; ANU evaluates websites based on quality of contents, institutional framework and design of appearance; the evaluation indexes of Lycos top 5% of the Web include content, design and overall performance; the evaluation indexes of Cyberstacks are composed of authority, accuracy of contents, clearance, uniqueness of contents, innovation, related comments and the demands of communities; SelectSurf evaluates websites based on contents, applicability, design and usability; the evaluation indexes of Agrus Clearing house are the statements of resources, content level, navigation design and institutional framework, etc.

Apart from the generally used website evaluation indexes, there are other evaluation methods put forward by some experts and scholarship aiming at certain fields, such as evaluation of academic resource website, evaluation of e-commerce websites, evaluation of library websites, evaluation of university websites, etc. By integrating the existing website evaluation indexes and website evaluation methods, based on multivariate statistics, the author, having investigated domestic and international science and technology service websites, extracts 14 indexes from the existing websites evaluation indexes to evaluate and sequence the 158 science and technology service websites of China from qualitative and quantitative aspects by using monitoring data.

PRINCIPAL COMPONENT ANALYSIS

Principle component analysis (PCA) was put forward by Karl Parson in 1901. This method was used for studying problems of psychology and education in the early stages. With the popularization of computers, PCA has been widely used in economics, sociology, biology, medical science, geology and so on. PCA is a kind of dimension reduction statistics and commonly used to deal with practical problems of multiple indexes. The background of the method is that the evaluation of a problem often involves multiple indexes, which often relate to each. If all the indexes are used, the calculation will be very complex and no correct result will be attained due to their multicollinearity. PCA aims to seek an appropriate linear transformation so as to combine multiple related indexes into several independent new indexes which can reflect the overall information. Then, based on the variances of new indexes, several indexes with the largest invariance will be used to substitute original indexes. In this way, only a few new indexes are enough to reflect the information of original indexes.

Specifically speaking, PCA is a method to extract 1 principle components from 1 data according to rate of contribution to reproduce the inner relationship between them by calculating proper value and proper vector of covariance matrix or correlation coefficient matrix. With this method, several independent or less related new indexes are used to replace multiple original indexes and these new indexes can reflect the information of original indexes as far as possible.

PCA, with comparatively stronger comprehensiveness and objectiveness, is an effective method to solve the quantification of qualitative problems.

EVALUATION OF SCIENCE AND TECHNOLOGY SERVICE WEBSITES BASED ON PCA

Evaluation Indexes: The evaluation indexes adopted in this paper are some indexes extracted from existing website evaluation indexes, including.

Scientificalness: The information contents shall be based on facts; the procedure description shall be sequenced; the conceptual statements shall be clear and accurate; principle analysis shall be easy, strict and reasonable; the practical application shall be able to stimulate interest and widen views. Paradox shall be avoided; falsification shall be strictly prohibited.

Interestingness: The information contents can motivate the advantage of pictures, texts, sounds and videos to statement as a whole. The teaching is carried out in education to attract readers. By interaction, readers are guided to participate in, experience, stipulate and keep reading interests.

Multimedia application: Aiming at the characteristics of content properties, images, texts, videos and other multimedia means are properly used to realize the organic integration of contents and forms. The modes of presentation are reasonable and very effective.

Usability: The user interface is friendly, simple and easy to operate, conforming to the browsing habits of publics.

Interactivity: A webiste shall be based on internet technologies. The mouse, keyboards and touchpad are reasonably used to provide all kinds of communication and interaction methods for the public. Advanced technologies are encouraged to use, such as image identification, sound identification, motion sensing and

so on to strengthen the ways of communication and interactivity for the public.

Search function within the website: The website provides fast and accurate site search engine.

Customer service: The service items provided by website for customers.

Number of daily page views (person/million persons): It is the total view times of the website on each day.

Number of daily visits: It is the times of independent visits of the website.

Records by Baidu: It is the number of website pages recorded by Baidu.

Home page opening speed: It is the time used to open the home page of website. The method of acquisition: If the website is visited every 20 min, the accumulated visit times and the time used to download the page content of the website to the local server are recorded and calculated for the mean value, and the result is the real opening time of the home page.

Updating rate of home page: It is the change frequency of home page within a certain period. The replacement of the home page of website includes: the content items, setting of columns, updating of webpage images. The acquisition method is to visit the website every 20 min. The total visit times and each updating of webpage are recorded. Then the updating times divides the total visit times and the result is the updating rate.

Number of back links of home page: it is the number of links by other website to the home page of this website.

Website access success rate: It is the probability of normal visits by public. Visit the website every 20 min. If the opening time of the web page does not exceed 60 sec, the page is successfully visited. The ratio between successful visit times and total visit times is the success rate of visiting the website.

Evaluation samples choice

Evaluation samples include: Chinese science and technology associations of all levels, Chinese science and technology societies, the system of CAS, well known we portals, social organizations and digital science and technological museums established by individuals, science and technology service websites (including science and technology channels or columns), 200 in total.

Method of identifying samples: The science and technology service websites, science and technology service websites channels or columns found by means of Google and other search engines; websites found by "friendly links", and "recommended sites" on technology sites; websites of science associations, science and technology community and societies of all levels and sites established by CAS, etc.

Work before evaluation

Artificial data collection: Organize experts to open the address and browse named technology sites one by one and evaluate them subjectively according to indexes like scientificalness, interestingness, use of multimedia, usability, interactivity, search function within the site, customer service and other qualitative indexes and score them with marks from 1 to 5.

Technology monitoring of website: Adopt self developed website monitoring system to monitor technology sites according to upgrading rate of home page, number of back links on home pate, success rate of visiting, number of daily page views, number of daily visits, records of Baidu, opening speed of home page and other objective quantitative indexes and record the monitoring results.

Standardization of evaluation indexes: As science and technology service websites are evaluated based on combining qualitative and quantitative methods and objective and subjective methods, the attribute value of evaluation indexes should be processed uniformly: some qualitative indexes can be quantified and the quantified indexes can be used together with other quantitative indexes. As to quantitative indexes, the influence caused by index units and dimension differences should be removed to avoid the occurrence of unreasonable results. As a result, the quantitative indexes should be processed to remove the dimension.

COMPREHENSIVE EVALUATION OF SCIENCE AND TECHNOLOGY SERVICE WEBSITES BASED ON PCA

Evaluation procedures:

- Identify analysis variables (i.e., evaluation indexes) to collect basic data
- Standardize the original data
- Calculate correlation coefficient matrix of the selected variables
- Extract principle components and calculate load matrix
- Calculate principle components and sequence them to obtain comprehensive evaluation results

KMO test and bartlett spherical test: The results of Table 1 indicate that sample data of science and technology service websites can be used for PCA. KMO value in Table 2 is 0.642, indicating that the correlation between evaluation is very strong, suitable for PCA. The following is results of Bartlett test results, indicating the significant Bartlett test, which proves that these variables are suitable for PCA.

Principle components' explanation on original indexes: Generally speaking, the ratio of variance of the principle components in the total variance illustrates the situation of the raw information represented by principle components. Table 2 shows the contribution rate and accumulated contribution rate of principle components. It can be seen that the accumulated contribution rate of front 4 principle components achieves 68.616%, representing most of raw information.

Table 3 is the loading coefficient matrix for making principle component analysis on all indexes. It shows the correlation coefficient between original variables and front 4 principle components. The larger the correlation coefficient is, the more loads of the principle component on these indexes. So the principle components mainly explained these indexes. On the contrary, the smaller the correlation coefficient is, the fewer roles played by these indexes on the principle components and such effect can be ignored. It can be seen that the first principle component has a high correlation with seven qualitative indexes including scientificalness, interestingness, usability, site search function, multimedia application, customer service and interactivity, so it mainly explains the information on the seven aspects; the second principle component mainly explains three quantitative indexes including daily page views, daily visits and record by Baidu, which reflects the technical differences of websites; the third principle component has comparatively strong positive correlation with and mainly explains the home page updating rate and the number of back links of home page and the fourth principle component shows high positive correlation with website access success rate and home page back links number, and it mainly explains the two indexes.

As one of the purposes of the principle component analysis is data dimension reduction, namely to deduct the 14 dimensions constituted by 14 indexes from now to the low dimensional space constituted by extremely few indexes. It is better to be two-dimensions so as to see the distribution of sample points. And Table 3 shows that the accumulated contribution rate of the first two principle components is only 49.863%, a low representation to raw information. Therefore, it is necessary for usability to conduct further treatment on the results of above principle component analysis.

It can be seen from Table 3 that, the first principle component is in positive correlation with all qualitative indexes (namely subjective indexes). If we make principle component analysis on all qualitative indexes in the original indexes independently and the first principle component generated in the result is still in positive correlation with all qualitative indexes, then the first principle component can be taken as level factor to sequence its scores and thus we can obtain the qualitative evaluation sequence result of all science and technology service websites. And then, we can independently make principle component analysis on the remaining quantitative indexes (namely objective indexes). Comprehensive evaluation can be conducted on various science and technology service websites according to the principle component analysis ofqualitative indexes and quantitative indexes.

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.689
Bartlett's Test of Sphericity	Approx. Chi-Square	1334.239
	df	91
	Sig.	.000

Table 2: Total variance explained

	Initial eigenvalues			Rotaion sums of squared loadings		
Component	Total	(%) of variance	Cumalative	Total	(%) of variance	Cumalative
1	4.373	31.234	31.234	4.170	29.788	29.788
2	2.827	20.191	51.425	2.810	20.075	49.863
3	1.318	9.416	60.841	1.349	9.635	59.498
4	1.089	7.776	68.616	1.277	9.119	68.616
5	0.940	6.712	75.329			
6	0.825	5.891	81.220			
7	0.779	5.562	86.782			
8	0.671	4.796	91.578			
9	0.489	2.494	95.072			
10	0.271	1.935	97.007			
11	0.166	1.186	98.193			
12	0.135	0.968	99.160			
13	0.108	0.773	99.933			
14	0.009	0.067	100.00			

Table 3: Component matrix

	Component			
Parameters	1	2	3	4
Scientificalness	0.683	-0.056	-0.253	-0.032
Interestingness	0.787	0.066	-0.060	0.124
Usability	0.832	0.046	0.068	0.169
Search function within the website	0.722	0.112	0.006	-0.060
Multimedia application	0.807	0.162	-0.024	0.001
Customer service	0.763	-0.060	0.167	-0.160
Interactivity	0.785	0.036	0.297	-0.049
Website access success rate	-0.032	-0.031	0.077	0.774
Updating rate of home page	-0.013	0.089	0.747	-0.117
Home page opening speed	0.027	0.090	-0.106	0.757
No. of daily page views	0.057	0.974	0.065	0.011
No. of backlinks of home page	0.073	0.199	0.709	0.095
Records by Baidu	0.100	0.890	0.268	0.077

Table 4: KMO and Bartlett's test on qualitative indexes

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.738
Bartlett's Test of Sphericity	Approx. Chi-Square	611.289
	df	21
	Sig.	0.000

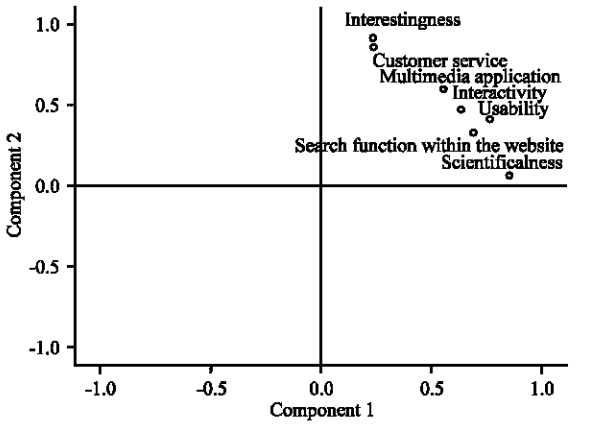

Fig. 1: Correlation between the first two principle components of qualitative indexes

The principle component analysis on qualitative indexes and quantitative indexes are respectively conducted in the following.

Principle component analysis on qualitative indexes: Principle component analysis is conducted on the seven qualitative indexes including scientificalness, interestingness, usability, site search function, multimedia application, customer service and interactivity.

It can be seen from Table 4 that the KMO value is 0.740 and the significance of Bartlett test achieves 0.000, showing that the qualitative data is suitable for principle component analysis.

Viewing from Table 5, the accumulated contribution rate of the first two principle components achieves 72.047%, representing most of raw information.

Figure 1 indicates the correlation between the first two principle components of qualitative indexes. It can be seen that the first principle component is in positive correlation with all qualitative indexes. Therefore, it can be taken as the level factor, so as to sequence the qualitative evaluation on all science and technology service websites with the first principle component scores.

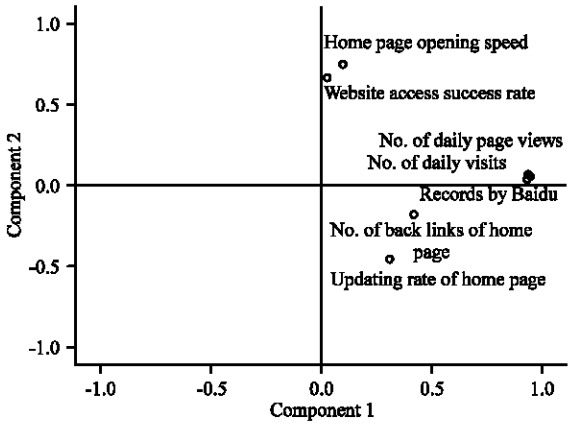

Fig. 2: Correlation between the first two principle components of quantitative indexes

Principle component analysis on quantitative indexes: Principle component analysis is conducted on 7 quantitative indexes including homepage updating rate, homepage openning speed, daily pageviews, daily visits, homepage backlink number, records by Baidu and homepage access success rate. The KMO and Bartlett's test on quantitative indexes shows that the KMO value is 0.631 and the significance of Bartlett test achieves 0.000, showing that the data is suitable for making principle component analysis. The total variance explained on quantitative indexes shows the accumulated contribution rate of the first two principle components achieves 60.628%, representing most of raw information.

It can be seen from Fig. 2 that the first principle component is mainly explained by three indexes including daily pageviews, daily visits and records by Baidu,

Table 5: Total variance explained on qualitative indexes

	Initial eigenvalues			Rotaion sums of squared loadings		
Component	Total	(%) of variance	Cumalative	Total	(%) of variance	Cumalative
1	4.171	59.592	59.592	2.599	37.135	37.135
2	0.872	12.455	72.047	2.444	34.912	72.047
3	0.748	10.690	82.737			
4	0.570	8.140	90.877			
5	0.342	4.888	95.765			
6	0.167	2.384	98.149			
7	0.130	1.851	100.00			

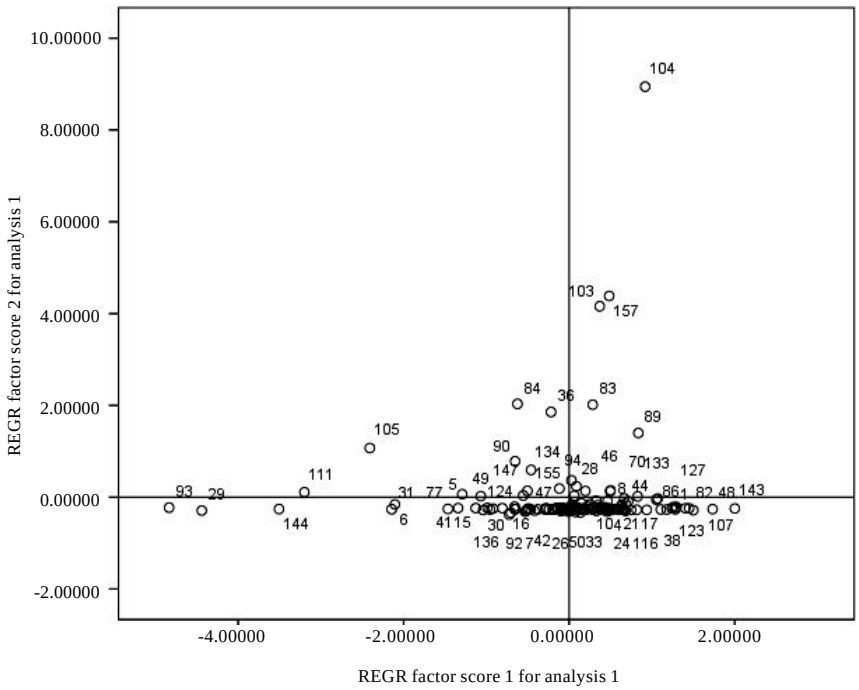

Fig. 3: Scatter diagram of qualitative sequence scores and quantitative sequence scores

reflecting the access situation of the website; the second principle component is mainly explained by such indexes as homepage openning speed, website access success rate, homepage updating rate, showing the technical differences of websites. In addition, the first principle component is in positive correlation with all quantitative indexes, so it can also be taken as level factor to sequence the quantitative evaluation of all science and technology service websites.

Comprehensive evaluation result: The scatter diagram is obtained through the qualitative sequence and quantitative sequence on the sample websites. It is shown in the Fig. 3.

In Fig. 3, the science and technology service websites located on the first and the fourth quadrants are better than average in terms of qualitative sequence scores; the science and technology service websites located on the first and the second quadrants are better than average in terms of quantitative sequence scores and the websites located on the fourth quadrant are in the low ranks in terms of qualitative and quantitative sequences. The websites on the first quadrant seem to have high ranks in qualitative and quantitative sequences. Therefore, the websites with good performance in qualitative sequence or (and) quantitative sequence can be promoted nationwide as superior websites.

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