Summer 6-30-2018

The Evaluation on Home Improvement Website's Efficiency Based on SBM-DEA

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Abstract: We built the efficiency evaluation index system of home improvement website's inputs and outputs. The SBM - DEA model is applied to evaluate the efficiency of 30 home improvement websites and the stability of relatively effective websites. Finally, we put forward some specific website optimization suggestions with the results. The purposes of this paper are to study the efficiency of home improvement websites and provide webmasters with optimization suggestions under limited input resources.

Keywords: SBM-DEA, home improvement website, efficiency evaluation, index system

1. INTRODUCTION

With the accelerated pace of urbanization in China in recent years, the demand for urban housing has increased year by year, which has brought a wealth of demand for home improvement industry. Many new O2O home improvement enterprises were born in the home improvement market in the Internet plus era. At the same time, many traditional home improvement enterprises began to establish e-commerce platform and joined the tide of the Internet home improvement. It is the problem that webmasters need to solve that how to optimize the home improvement website to get a leading position in the fierce competition. Therefore, it is well worth studying the efficiency of home improvement websites and the rationality of website design.

In the literature, various approaches have been proposed to evaluate the website's efficiency. For instance, Kang et al. applied E-S-QUAL for assessing e-commerce website service quality effectively and proposed a fuzzy hierarchical TOPSIS based on E-S-QUAL for evaluating e-commerce [1]. Yi et al. applied the system comprehensive evaluation method to evaluate 40 agricultural enterprise websites in Guangdong Province [2]. Tang et al. built a website user efficiency indicator system based on user behavior model and information construction theory, and selected 12 representative government websites for empirical research [3]. Li et al. evaluated 72 domestic e-commerce websites using factor analysis method and correspondence analysis method [4]. ERTUĞRUL et al. applied MACBETH and PROMETHEE methods to compare performances of online books shopping websites in Turkey [5].

There are many references evaluating website efficiency based on DEA method. Yang et al. measured returns to scale and total factor productivity in e-commerce based on DEA [6]. Yuan et al. applied SBM-DEA model and super-efficiency SBM-DEA model to evaluate the efficiency of 13 domestic insurance e-commerce websites and analyzed the stability of relatively effective websites [7]. Yang et al. applied DEA models and traditional production theory to account for how scale affects efficiency in pure e-commerce firms [8]. Zhang evaluated 24 e-commerce websites based on CCR model [9]. Huang et al. used CCR model, BCC model and super-efficiency model compare the differences of efficiency between provincial archives websites [10].

The purposes of this paper are to study the efficiency of home improvement websites, provide webmasters with optimization suggestions based on results and guide them to improve the efficiency of website under limited input resources. We selected 30 domestic home improvement websites as research sample and built the efficiency evaluation index system of home improvement website's inputs and outputs. Then, we applied the SBM-DEA model to evaluate the efficiency and stability of sample websites. Finally, we put forward some

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specific website optimization suggestions with the results.

This paper is organized as follows: section 2 is research method, section 3 is index system construction and data acquisition, section 4 is result and analysis, and section 5 is conclusions and suggestions.

2. RESEARCH METHOD

DEA model was developed by Charnes et al. in 1978 [11]. It is a well-established nonparametric methodology for evaluating the relative efficiency of a set of comparable entities called decision making units (DMUs) with multiple inputs and outputs.

Traditional DEA models, such as CCR model and BBC model, evaluate the efficiency of decision-making units only from the ratio of input to output, but do not consider the problem of slack variables, resulting in the slackness of input-output and the deviation of measured results [12]. In order to study the efficiency of home improvement websites, we applied the output-oriented SBM model based on laxity variables and the super-efficiency SBM-DEA model to evaluate the website resource input-output efficiency and website stability.

3. INDEX SYSTEM CONSTRUCTION AND DATA ACQUISITION

3.1 Index system construction

We selected input categories and output categories to build the basic index system of home improvement website. Referring to other literature [12]-[14], we chose the following input and output categories as needed (Figure 1). Besides, we selected 6 input indicators and 3 output indicators to design the efficiency evaluation index system of home improvement website (Table 1).

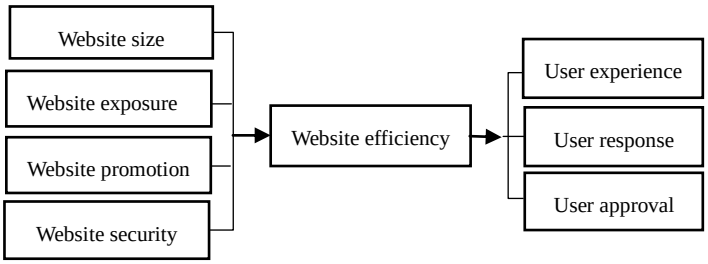

Figure 1. The basic index system of home improvement

Table 1. The efficiency evaluation index system of home improvement website

Evaluation Category		Evaluation indicator
Input indicator	Website size	X_1: Total number of web pages
		X_2: Average page size
	Website exposure	X_3: Number of distinct foreign sites referenced
	Website promotion	X_4: Total number of meta tags
		X_5: Total number of foreign sites references
	Website security	X_6: Website security test score
Output indicator	User experience	Y_1: Website access speed
	User response	Y_2: Daily page view
	User approval	Y_3: Baidu index

The input and output indicators in Table 1 are explained as follows:

(1) The input indicators

The total number of web pages (X_1) refers to the total number of static pages in the root directory and subdirectory. The total number of website pages reflects the overall scale of website construction. A large number of pages means a large overall scale and high cost of maintaining the website [7].

The average page size (X_2) refers to the average size of all pages in the website (calculated by KB). The larger the average page size, the more abundant the content of the website.

The number of distinct foreign sites referenced (X_3) refers to the total number of links to different external websites on this website. To some extent, this indicator reflects the cost of maintaining the stability of the

content and the internal friend links [7].

The total number of meta tags (X_4) refers to the total number of meta tags used throughout the website, which reflects the input of website promotion.

The total number of foreign sites references (X_5), also called the total number of backlink, refers to the number of different external websites pointing to the website. The broad exposure can attract search engine crawlers to crawl the website quickly, which can enhance the speed of web content collection and improve the website experience. Therefore, this indicator also reflects the input of website promotion.

Security test score (X_6) refers to a score of vulnerability, tampering or fraudulent content. This indicator reflects the input of website safety and has a direct impact on the outputs.

(2)The output indicators

Website access speed (Y_1) reflects the user experience in the process of visiting the website. A page with a slow load speed can leave a bad impression on users. Thus, we used the reciprocal of website access speed as one of the output indicators.

Daily page view (Y_2) reflects the effect of user response. We can learn if a website has a good content readability and a high conversion rate from this indicator.

Baidu index (Y_3) refers to the index of a website in keywords ranking, traffic and user experience. This indicator reflects the comprehensive optimization of a website. We chose this indicator because better website optimization means a higher level of user approval.

3.2 Data acquisition

(1) Sample website selection

We selected the top 30 home improvement websites as the DMUs from 2016 annual list of the best Internet home improvement enterprises [15] (Table 2).

Table 2. The sample websites

No.	Name	URL	No.	Name	URL
1	Tubatu	http://www.to8to.com	16	Wanshifu	http://www.wanshifu.com
2	Maclline	https://jz.mmall.com	17	Boluoni	http://www.boloni.cn
3	Qijia	http://www.jia.com	18	Meilele	http://www.meilele.com
4	Liba	http://www.liba.com	19	Baianju	http://www.bnq.com.cn
5	Kujiale	http://www.kujiale.com	20	Aikongjian	http://www.ikongjian.com
6	Qianggongzhang	http://www.7gz.com	21	Huizhuang	http://www.huizhuang.com
7	Oupai	http://www.oppein.cn	22	Longfa	http://www.bjlongfa.cn
8	Juranzhijia	http://www.juran.com.cn	23	Mingjia	http://www.mjdec.com
9	Aifuwo	http://www.fuwo.com	24	Xingyi	http://www.xydec.com.cn
10	Taipingyang	http://www.pchouse.com.cn	25	Xinju	http://www.homekoo.com
11	Woaiwojia	http://www.525j.com.cn	26	Hongmayi	http://www.hmyzs.com
12	Tubashu	http://www.tobosu.com	27	Jikemeijia	http://www.mj100.com
13	Jintanglang	http://www.jtljia.com	28	Pingguo	http://www.apple2003.com
14	Dongyirisheng	http://www.dyrs.com.cn	29	Yuanzhou	http://www.yz-china.com
15	Wangzhu	http://www.lcds365.com	30	City family	http://www.csrj.com.cn

(2) Data acquisition

After confirming the sample websites, we used Maxamine Web Analyst software to collect the total number of web pages, the average page size, the number of distinct foreign sites referenced, the total number of meta tags and the total number of foreign sites references. Then, we used Chinaz Tool (http://tool.chinaz.com) to collect website security test score, website access speed and Baidu index. Finally, we used Alexa Tool to collect daily page view. Our acquisition work was completed within 2 hours from 9:00 am to 11:00 am in order to make the collected data comparable and reliable. And the acquisition work lasted for 15 days from May 1 to May 15

in 2017. Finally, we calculated the average number of each indicator within 15 days as the model data (Table 3).

Table 3. The collected model data

DMU	X_1	X_2	X_3	X_4	X_5	X_6	Y_1	Y_2	Y_3
1	59.7	483	518	180	3,889	96.0	3,248,000	0.240	8
2	251.3	561	22	60	564	100.0	72,100	0.857	4
3	55.8	627	356	32	1,341	96.0	178,000	0.581	6
4	89.0	23	32	13	301	100.0	195,500	0.255	6
5	13.0	1,745	56	4	72	100.0	592,000	0.948	6
6	54.0	1,557	926	184	2,057	97.0	511,000	0.492	4
7	119.9	573	171	26	536	95.0	48,500	0.978	6
8	968.3	149	198	2	2,587	97.0	50,000	1.567	4
9	26.5	634	214	79	990	100.0	440,500	0.676	4
10	13.9	769	239	21	1,352	98.0	326,500	0.333	7
11	126.9	558	681	140	2,692	100.0	38,900	0.584	6
12	71.7	626	923	91	4,479	100.0	170,000	0.437	7
13	149.6	34	96	76	488	100.0	30,200	0.634	2
14	43.5	574	302	35	1,230	99.0	70,100	0.391	4
15	294.5	551	109	86	631	100.0	22,300	0.700	1
16	12.0	3,657	40	6	109	34.0	32,000	0.728	4
17	205.6	159	85	235	937	50.0	21,500	0.643	1
18	54.6	1,011	45	4	70	53.0	344,500	0.392	8
19	515.8	154	18	129	415	100.0	10,400	1.007	4
20	221.3	236	535	407	3,634	100.0	19,100	1.245	2
21	24.7	28	32	135	285	100.0	14,750	0.911	1
22	7.5	598	30	14	182	100.0	21,200	0.641	3
23	281.4	533	31	284	1,882	95.0	9,750	0.323	3
24	1,709.7	176	78	348	1,383	100.0	30,300	0.413	4
25	52.2	564	154	33	1,323	100.0	163,000	0.349	6
26	926.5	477	47	182	756	100.0	10,550	0.639	2
27	74.8	418	10	514	1,411	39.5	8,750	1.340	1
28	1,728.0	595	1,864	98	2,077	100.0	22,800	4.739	4
29	239.8	513	398	289	3,571	90.5	12,400	0.941	3
30	1,479.7	451	1,836	480	9,883	100.0	9,570	1.058	4

4. RESULT AND ANALYSIS

4.1 Website efficiency analysis

We used MaxDEA 6.0 software to calculate the technical efficiency (TE) and pure technical efficiency (PTE) with SBM-O-V model and SBM-O-C model. Then, we calculated the scale efficiency (SE) and returns to scale (RTS) according to SE=TE/PTE (Table 4).

Table 4. The result of 30 home improvement websites based on SBM-DEA

DMU	TE	PTE	SE	RTS	DMU	TE	PTE	SE	RTS
1	1	1	1	Constant	17	0.1531	1	0.1531	Increasing
2	1	1	1	Constant	18	1	1	1	Constant
3	0.6786	0.6880	0.9862	Decreasing	19	1	1	1	Constant
4	1	1	1	Constant	20	0.0661	0.0800	0.8257	Decreasing
5	1	1	1	Constant	21	1	1	1	Constant
6	0.4152	0.4403	0.9431	Decreasing	22	1	1	1	Constant
7	1	1	1	Constant	23	0.1006	0.1092	0.9214	Increasing
8	1	1	1	Constant	24	0.1610	0.1626	0.9902	Decreasing
9	0.7615	0.7627	0.9983	Decreasing	25	0.4723	0.4838	0.9762	Increasing
10	1	1	1	Constant	26	0.0848	0.0866	0.9799	Decreasing
11	0.0507	0.0508	0.9989	Decreasing	27	1	1	1	Constant
12	0.2459	0.2478	0.9926	Decreasing	28	1	1	1	Constant
13	0.4369	0.4379	0.9979	Decreasing	29	0.0178	0.0206	0.8646	Decreasing
14	0.2284	0.2587	0.8829	Increasing	30	0.0120	0.0121	0.9922	Decreasing
15	0.0952	0.0967	0.9843	Decreasing	Mean	0.5993	0.6313	0.9496	
16	1	1	1	Constant	S.D.	0.4035	0.3981	0.1518	

Table 4 illustrates the TE, PTE, SE and RTS of the sample based on SBM-DEA model. The technical efficiency of 14 websites are equal to 1, indicating that these websites are in the production frontier of SBM model with relatively effective outputs. There are 11 websites with efficiency values between 0 and 0.4. It is obviously that over one-third of sample websites have low output efficiency. Thus, it is necessary for these websites to improve resource utilization and adjust inputs according to the shadow prices. Moreover, the average value of TE is 0.5993, which suggests 40.07% of website resources are ineffective in website outputs. The standard deviation of TE is 0.4035, which indicates that there is a considerable efficiency gap between the sample websites. It is illustrated that a polarization phenomenon exists in the input efficiency of home improvement websites in China.

As for scale efficiency, 14 websites whose SE value are equal to 1 are of scale effective, and 15 websites whose SE value are between 0.8 and 1 are of light scale non-effective. The mean SE value is 0.9495 and the standard deviation of SE is 0.1518 indicating that most of the sample websites have reached the best scale, or have a small difference with the best scale. Thus, the overall scale of sample websites is relatively stable. In terms of RTS, 14 scale effective websites are in the CRS stage, which indicates that the scale of each website has a reasonable correspondence with the inputs and outputs. Thus, these websites can maintain their current scale and develop steadily. 12 scale non-effective websites are in the DRS stage, so they should properly reduce website scale and input resources to cut down the cost. 4 scale non-effective websites are in the IRS stage, indicating that their output growth rate is higher than the input growth rate. Therefore, these websites should increase the input and scale to make full use of scale effect for a CRS stage.

As for PTE, the mean PTE value is 0.6312 indicating that the overall technology of the sample websites is at a medium level with much improvement space. The standard deviation of PTE is 0.3981, which suggests huge technical gap might exists among some websites.

The mean PTE value (0.6312) is smaller than mean SE value (0.9495). As PTE is mainly influenced by the management and technical level of websites and SE is mainly influenced by the scale of websites, this clearly illustrates that the efficiency of input resources is lower than that of website scale construction among home improvement websites. Therefore, home improvement websites need to increase their technical input according to the stage of their own scale returns, thereby enhancing the overall technical efficiency.

4.2 Super efficiency analysis of effective websites

Based on super-efficiency SBM-O-V model, we calculated the super efficiency values and analyzed the stability of 14 effective websites by means of DEA-SOLVER Pro software (Figure 3).

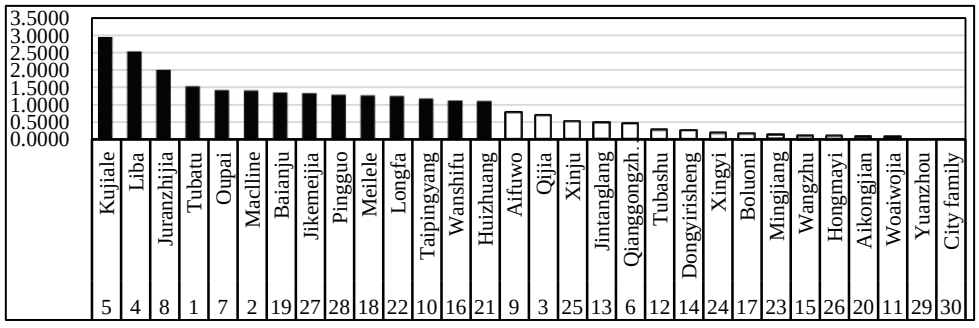

Figure 3. Super efficiency ranks of home improvement websites

Figure 3 presents the super efficiency value of the sample websites, illustrating that the super efficiency of the 16 non-effective websites are the same as those of SBM-DEA, but the super efficiency of the 14 effective websites are quite different from those of the original SBM-DEA. It indicates the relatively effective websites remain effective in different stability. The higher the super efficiency, the higher the stability when a website

increasing input resources. Take Kujiale(5) and Maclline (2) for example. Kujiale's super efficiency value is 2.9091 and Maclline's super efficiency value is 1.3987. As illustrated in Figure 4, 2 websites are effective when increasing their input resources by 1.3987 times. However, when increasing input resources by 2.9091 times, Kujiale still stay relatively effective while Maclline becomes non-effective website because of high inputs ratio.

Compared with 2016 annual list of the best Internet home improvement enterprises, the relatively effective websites in the top 10 of the list still ranks top in terms of stability maintenance. For instance, Kujiale ranks No.1 in terms of stability and ranks No.5 in the annual list, Tubatu ranks No.1 in the annual list and ranks No.4 in terms of stability, indicating that the home improvement websites with strong strength can maintain relatively effective and obtain more ideal outputs when increasing input resources. However, top 10 to 30 of annual list varies widely in terms of stability. Jikemeijia(27) and Pingguo(28), at the end of the annual list, have higher stability than other websites which are in the front rank. It suggests that the lower-ranking websites can increase their input resources and site's scale appropriately under the condition of effectively maintaining their stability.

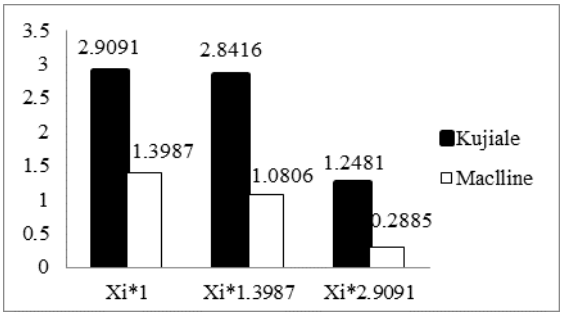

Figure 4. The super efficiency values of input changes

4.3 Input redundancy and output insufficiency analysis of non-effective websites

Based on SBM-I-V model and SBM-O-V model, we used MaxDEA 6.0 software to calculate the projection of input and output indicators of 16 non-effective websites. Then we calculated input redundancy rate and output insufficiency rate so as to put forward some suggestions. The formulas of input redundancy rate and output insufficiency rate are as follows:

$$\text{Input redundancy rate}=\frac{\text{original value-projection value}}{\text{original value}} \quad (1)$$

$$\text{Output insufficiency rate}=\frac{\text{projection value-original value}}{\text{original value}} \quad (2)$$

It can be seen from Table 5 that all 9 indicators illustrate the results of input redundancy and output insufficiency. The result of SBM-I-V model illustrates that non-effective websites have a high input redundancy rate in both website exposure and website promotion with an average rate of 50%, and the rate of 68% in the total number of foreign sites references (X_5). It illustrates that most of the home improvement webmasters prefer to website promotion inputs and tend to use META tags and links for SEO.

As for every single website, it can be found that City family (30) with the lowest TE has a high degree of redundancy in all input indicators except the security test score. And its redundancy rate of total number of foreign sites references is 95% and the insufficiency rate of Baidu index and daily PV are 64% and 24517%, which indicates there is a phenomenon that the current input of website is larger than the input of ideal website's scale and the output is extremely scarce. This is partly because the website pays too much attention to the accumulation of resources, but ignores the effective allocation of resources, resulting in high redundancy, page browsing shortage and poor responsiveness. Therefore, City family (30) should reduce foreign links and META tags in the promotion and keep the high quality links.

Xingyi (24) with low TE has a small number of input resources. For example, the total number of web pages and the number of distinct foreign sites referenced are only 176 and 78, while the average size of pages is as high as 1709.7KB, which reflects the resource allocation of the website is unreasonable, such as the average web page size is too large, the problem of slow page loading speed etc. Therefore, Xingyi (24) should reorganize its page layout, reduce the size of displayed images and add some service content, thereby enhancing its user experience.

Even if the input redundancy rate is close to zero, it does not mean that the resources of the website is well allocated, which may be the illusion caused by insufficient input. For instance, Boluoni (17) has no input redundancy or output insufficiency. However, when combine with its security test score of only 50 points, we can find Boloni (17) has not been repaired a number of high-risk vulnerabilities. Moreover, the Baidu index is closely related with traffic and keyword rankings. But the Baidu index of Boluoni (17) is only 1 point, which means the website has not been well invested in efficient resources to optimize the search engine. Therefore, Boluoni (17) should add security resources, repair web page vulnerabilities, improve website security system construction, and carry out necessary search engine optimization.

Table 5. The input redundancy rate and output insufficiency rate of non-effective websites

DMU	TE	X_1	X_2	X_3	X_4	X_5	X_6	Y_1	Y_2	Y_3
		Input redundancy rate						Output insufficiency rate		
		Original value						Original value		
3	0.6786	0.00	0.00	0.58	0.40	0.47	0.02	1.36	0.00	0.00
		55.8	627	356	32	1341	96	178000	0.581	6
6	0.4152	0.67	0.61	0.89	0.80	0.65	0.00	2.82	0.24	0.76
		54	1557	926	184	2057	97	511000	0.492	4
9	0.7615	0.09	0.00	0.62	0.26	0.46	0.07	0.88	0.00	0.05
		26.5	634	214	79	990	100.0	440500	0.676	4
11	0.0507	0.19	0.51	0.86	0.86	0.85	0.02	55.98	0.00	0.10
		126.9	558	681	140	2692	100	38900	0.584	6
12	0.2459	0.00	0.00	0.92	0.87	0.93	0.23	9.11	0.00	0.00
		71.7	626	923	91	4479	100	170000	0.437	7
13	0.4369	0.45	0.14	0.62	0.00	0.26	0.00	3.15	0.00	0.70
		149.6	34	96	76	488	100	30200	0.634	2
14	0.2284	0.45	0.00	0.89	0.64	0.85	0.05	8.02	0.00	0.57
		43.5	574	302	35	1230	99	70100	0.391	4
15	0.0952	0.96	0.18	0.72	0.50	0.67	0.00	24.43	0.00	3.59
		294.5	551	109	86	631	100	22300	0.700	1
17	0.1531	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		205.6	159	85	235	937	50	21500	0.643	1
20	0.0661	0.00	0.62	0.56	0.72	0.87	0.00	34.11	0.00	0.37
		221.3	236	535	407	3634	100	19100	1.245	2
23	0.1006	0.69	0.90	0.03	0.81	0.79	0.00	22.70	1.27	0.51
		281.4	533	31	284	1882	95	9750	0.323	3
24	0.1610	0.96	0.86	0.59	0.88	0.79	0.00	15.06	0.00	0.39
		1709.7	176	78	348	1383	100	30300	0.413	4
25	0.4723	0.00	0.00	0.71	0.69	0.83	0.17	2.94	0.26	0.00
		52.2	564	154	33	1323	100	163000	0.349	6
26	0.0848	0.94	0.95	0.32	0.54	0.61	0.00	30.18	0.00	1.47
		926.5	477	47	182	756	100	10550	0.639	2
29	0.0178	0.74	0.43	0.81	0.57	0.87	0.00	142.15	0.00	0.70
		239.8	513	398	289	3571	90.5	12400	0.941	3
30	0.0120	0.81	0.78	0.85	0.86	0.95	0.00	245.17	0.00	0.64
		1479.7	451	1836	480	9883	100	9570	1.058	4
Mean	—	0.44	0.37	0.62	0.59	0.68	0.03	37.38	0.11	0.62
		371.17	516.88	423.19	186.31	2329.81	95.47	108573.13	0.63	3.69

5. CONCLUSIONS AND SUGGESTIONS

The conclusions are as follows: (1) Chinese home improvement websites have a medium overall efficiency and a stable overall scale. (2) The website scale construction is more effective than the input resources in home improvement websites. The medium standard deviation of PTE reflects huge technical gap might exists among some websites. (3) Compared with 2016 annual list of the best Internet home improvement enterprises, the relatively effective websites in the top 10 of the list still ranks the top in terms of stability, while the top 10 to 30 of the list varies widely in terms of stability. (4) Most of the webmasters prefer to website promotion inputs and tend to use META tags and links for SEO, which illustrates a lack of website promotion accuracy.

The following suggestions are put forward: (1) Optimize website resource allocation. Webmasters need to redistribute and optimize the input resources, such as allocating the extra input to Baidu index, PV and access speed so as to improve the website's efficiency. (2) Pay attention to core service content. Some home improvement websites have beautiful page design only in introduction of enterprise and service. But the content of purchase and user interaction, which can bring profits, are designed in online customer service module. Therefore, the page design of home improvement website should be optimized not only in the beauty of the page but also in the purchase content to enhance the quality of content construction and attract and keep users. (3) Improve website's promotion quality. The greater the external impact of backlinks, the higher the cost of maintaining the stability of the website. Therefore, the websites with high redundancy should appropriately reduce the number of backlinks and META tags, pay attention to the quality of the links and the reliability of the link promotion platform. (4) Optimize search engine. A high search engine rankings means high probability of users accessing the website and a big number of page views. Thus, some redundant resources should be allocated to the website's search engine optimization. Improving the quality of links and keyword can improve the website's efficiency. (5) Improve the website scale according to the current situation. The relatively effective websites can combine their super efficiency values and enterprises' current situation to increase the input resources of their own website and core competence.

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