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The Evaluation Research of ISO Standard Adoptive Influence Based on RSR

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Abstract. This article starts from the adoptive relationship, evaluates the influence of ISO standards through the 5 evaluation dimensions (strength, width, validity, viscosity and conversion speed of adoption) and 5 objects (China, America, Europe, National Standard Organization and Other Asian Organizations) of this influence. We solve the scores of ISO standards under each influence object using RSR method.

1. Introduction

Standard is to point to get the best order in a certain scope, the result of the activity or the provisions of common and repeated use of rules, guidelines or characteristics of files, formulated on the basis of the document and approved by a recognized organization. With the rapid economic globalization, the political and economic restructuring of the world has accelerated, and international competition has entered a new stage. The deep research in the standard is beneficial to promote standardization system innovation, improving the standard of market adaptability, constantly strengthen the consciousness of the standardization of the whole society and promote the status of China in international standardization activities. To occupy an advantageous position in the field of international trade, our country should do the research of standard strategy, strengthen the development of standard and establish a more mature standard system.

Standard adoptive relationship is one of the important ways in which standardization organizations interact with each other. It is also a bridge between the standards of the world's organizations.

ISO standards have an influence on standards from many country or standard organizations, and many national standards adopt ISO standards. The research on the influence of ISO standards is very important, which is conducive to the development, promulgation and implementation of standards in China.

There are few literatures on relevant quantitative studies abroad. The evaluation index system for enterprise standards and industry standards can provide ideas for the establishment of the standard adoption of influence evaluation index. Among them, the enterprise standard evaluation index can be divided into three categories: constraint index, routine index and additional score index. These three types of indicators are evaluated from the four perspectives of conformity assessment, level evaluation, normative evaluation and consistency evaluation [1]. G.H Ren and others [2] study from the perspective of standard applicability evaluation index system and standard applicability evaluation index can be divided into the standard technology, structure and contents of the coordination of compatibility, standard, application level and standard of the five secondary indicators, 10 third-level indicators. Sun guozi et al. [3] proposed a linear weighted MIQM model in the study of Weibo influence. Due to the complexity of factors affecting or things too much, when we evaluate things, we

usually only take a limited number of main indicators to carry out the analysis. In addition, the evaluation information is often not complete and accurate and that make the evaluation have the feature of grey. Therefore, this multi-level grey evaluation model is adopted to propose a more suitable model design for standard contribution evaluation [4]. Yunpeng Chen et al. [5] proposed the standard influence evaluation method based on the standard adoption strength, adoption width, adoption validity, adoption of viscosity, and conversion speed five factor model. This paper just gives the model and only evaluates the influence of the standard from the perspective of bibliometrics and applies GB data to measure the influence of ISO standard unilaterally.

We did some research on standard drafting unit evaluation before. This could give us some direction of evaluating for the influence of a standard. We use the ordered factor analysis model [6] and Yunpeng Chen et al. used AHP [7] to evaluate the standard drafting units. And they give a result of multidimensional descriptive statistics about this question [8]. They also give 3 aspects of standard evaluation. They are the number of classes index, the quality of classes index and the value of classes index analysis. And this paper focuses on the first aspect [9].

In this paper, we mainly study the influence of ISO standard toward 12 standard organization from the world based on adoptive relationship. We could give 13 different ISO standard organization's scores and a composite score at last. Through these scores, we could get the degree of influence of ISO in different regions, countries, and even different industries.

2. Model

2.1. RSR Method

The basic principle of RSR (rank-sum Ration) comprehensive evaluation is that the dimensionless statistic RSR is obtained by calculating the rank of each element in an n-row and m-column matrix. Using the method of rank sum, the concept of rank sum ratio is introduced to nondimensionalize the index data [10].

The m evaluation indexes of n evaluation objects were arranged into the original data table of m columns in n rows. The rank of each evaluation object of each index was calculated.

The rank sum ratio RSR value is arranged from small to large, and the corresponding downward cumulative frequency is calculated. Then, the percentage and probability unit comparison table are checked to obtain the probability unit Y.

Pearson correlation analysis was conducted for RSR and Y, and linear regression equation was calculated by taking the probability unit Y corresponding to the cumulative frequency as the independent variable and RS value as the dependent variable.

According to the corresponding RSR estimate calculated by regression equation, the evaluation objects are ordered and classified by the reasonable or the best division method.

2.2. Data Sources

We evaluate the ISO standard organization use the database of ISO, GB, ANSI, ASME, ASTM, BS, DIN, NF, UL, IEC, IEEE, JIS and HB. GB is database of Chinese national standard, it mainly includes GB, GB/T and GB/Z. ANSI, ASME and ASTM are the database of the United States standard. BS, DIN, NF came from the United Kingdom, Germany and France respectively. These countries all belong to Europe. IEC and IEEE are the two of the most famous international standard organization. JIS and HB, the first is the database of Japanese standard, the second is belong to China, an industry standard named Chinese aviation industry standard. As for the UL, it is a British standardization organization named Underwriter Laboratories Inc.

2.3. Indicator system

We have 5 second-level indicators and 16 third-level indicators for evaluating the ISO influence. The second-level indicators are the adoption strength, adoption width, adoption validity, adoption of viscosity and conversion speed. Each second-level indicator has its next level indicators. So we could

compute the influence of ISO toward China, America, Europe, international organizations and other organizations in Asian through these 16 values of indicators.

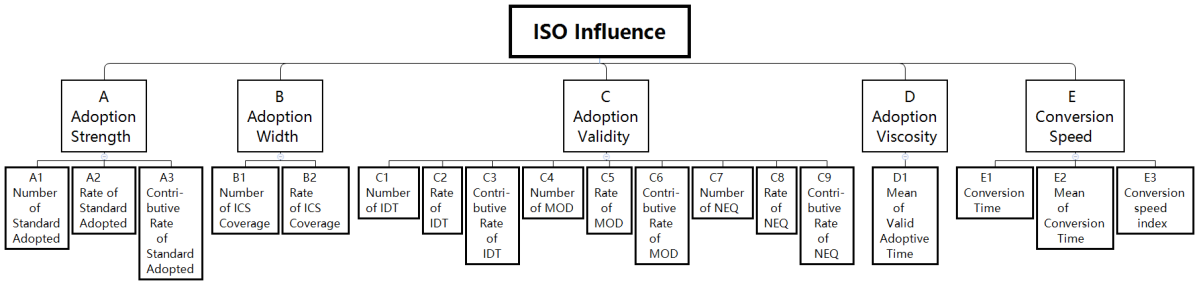

Figure 1. Evaluation Indicators System of ISO Influence Based on Adoption Relation.

The number of standard adopted (A1) is that the number of standard which adopted the ISO standard in database. The rate of standard adopted (A2) is that the ratio of A1 and the number of all standard in that database. The contribution rate of standard adopted is that the ratio of A1 and the number of standard which adopted any other standard. The number of ICS coverage (B1) means that the coverage total number of international classification of standards. And the rate of ICS coverage (B2) is that the ratio of B1 and the sum of ICS (40). The number of IDT, MOD and NEQ (C1, C4, C7) are the number of standard which identical adopted ISO, modify adopted ISO and non-equivalent adopted ISO. The rate of IDT, MOD and NEQ (C2, C5, C8) are the ratio of C1, C4, C7 and the sum of standard in the database. The contribution rate of IDT, MOD and NEQ (C3, C6, C9) are the ratio of C1, C4, C7 and the sum of standard which adopted any other standard. The mean of valid adoptive time (D1) has two situations. When the standard is revocatory, D1 is the revocation date minus release date. When the standard is currently effective, D1 is the current date minus release date. This paper chooses the 2018.04.24 as the current date. The conversion time (E1) is the release year of every standard minus the release year of ISO standard which adopted. Then, the mean of conversion time (E2) is the average of all conversion time. The conversion speed index is the ratio of E1 and E2.

Table 1. Index formula comparison table.

Indicator	Formula	Indicator	Formula	Indicator	Formula	Indicator	Formula
A^1	A_i^1	B^2	$B_i^1/40$	C^4	C_i^4	C^8	C_i^7/α_i
A^2	A_i^1/α_i	C^1	C_i^1	C^5	C_i^4/α_i	C^9	C_i^7/ε_i
A^3	A_i^1/β_i	C^2	C_i^1/α_i	C^6	C_i^4/θ_i	E^1	$\Sigma_e(T_e - P_e)$
B^1	B_i^1	C^3	C_i^1/δ_i	C^7	C_i^7	E^2	E_i^1/β_i
D^1		$\Sigma_e(T_{1e} - T_e)/e$ or $\Sigma_e(T_{2e} - T_e)/e$				E^3	E_i^1/E_i^2

Where, i and e are the i^{th} standard organization and eth standard. α_i, β_i, δ_i, θ_i, ε_i, T_{1e}, T_{2e}, T_e, P_e are sum standard of organization i, sum standard which adopted any standard of organization i, sum standard which IDT, MOD, NEQ any other standard of i, the abolish date of abolish standard, current date (2018.04.24), the release date of the eth standard, the release date of the adopted standard of eth standard.

2.4. Empirical study.

Using the RSR method, the indexes were first ranked. Among the 18 indicators, the conversion time (E1) and conversion speed index (E3) are indicators for each standard in each database. But the RSR method focuses on the overall database situation. Therefore, when using RSR method, these two indicators are not considered. The mean conversion time (E2) was used to investigate the conversion speed. That is, there are 16 indicators finally adopted.

Among them, the number of NEQ (C7), rate of NEQ (C8), contribution rate of NEQ (C9), the mean conversion time (E2) are lower-better indicators, from the number of standard adopted (A1) to

the contribution rate of MOD (C6) are higher-better indicators. Rank each index data according to the principle that the greater the value of higher-better indicator should have the greater the rank number, and the smaller the value of lower-better indicator should have the greater the rank number.

Table 2. Indicator value table of ISO standard adoptive influence.

Standard Organization	A:Adoption Strength			B:Adoption Width		C:Adoption Validity									D:Adoption Viscosity	E:Conversion Speed
	A1	A2	A3	B1	B2	C1	C2	C3	C4	C5	C6	C7	C8	C9	D1	E2
ASTM	0	0.00%	0.00%	0	0.00%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%	NULL	NULL
UL	0	0.00%	0.00%	0	0.00%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%	NULL	NULL
ASME	1	0.10%	0.17%	1	2.50%	1	0.10%	0.17%	0	0.00%	0.00%	0	0.00%	0.00%	23.00	18
IEC	19	0.23%	0.28%	4	10.00%	19	0.23%	0.30%	0	0.00%	0.00%	2	0.02%	0.42%	5.16	0.11
IEEE	46	3.41%	6.76%	4	10.00%	45	3.34%	6.65%	1	0.07%	20.00%	4	0.30%	44.44%	12.02	1.37
ANSI	1244	6.15%	19.24%	27	67.50%	1133	5.60%	18.04%	52	0.26%	33.12%	52	0.26%	53.61%	15.78	1.57
HB	1388	1.52%	31.55%	37	92.50%	447	0.49%	44.79%	403	0.44%	32.09%	357	0.39%	23.00%	13.73	9.8
JIS	4409	36.24%	73.02%	39	97.50%	1560	12.82%	66.90%	2759	22.68%	77.33%	95	0.78%	65.97%	11.99	12.19
GB	7452	18.82%	62.55%	38	95.00%	3883	10.02%	64.73%	2262	5.84%	66.24%	610	1.57%	48.61%	10.57	9.84
DIN	8125	21.49%	30.14%	40	100.00%	7390	19.54%	28.36%	907	2.40%	56.72%	64	0.17%	26.89%	12.53	1.95
NF	9942	27.48%	35.19%	40	100.00%	9369	25.90%	33.84%	184	0.51%	34.65%	480	1.33%	78.18%	13.55	1.97
BS	15288	40.66%	47.35%	40	100.00%	14966	39.80%	47.08%	365	0.97%	49.19%	482	1.28%	41.48%	11.51	0.79

Table 3. Indicator rank table of ISO standard adoptive influence.

Standard Organization	A:Adoption Strength			B:Adoption Width		C:Adoption Validity									D:Adoption Viscosity	E:Conversion Speed	16 index RAR
	A1	A2	A3	B1	B2	C1	C2	C3	C4	C5	C6	C7	C8	C9	D1	E2	
ASTM	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	11	11	11	NULL	NULL	0.313
UL	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	11	11	11	NULL	NULL	0.313
ASME	3	3	3	3	3	3	3	3	2.5	2.5	2.5	11	11	11	10	1	0.393
IEC	4	4	4	4.5	4.5	4	4	4	2.5	2.5	2.5	9	9	9	1	10	0.409
IEEE	5	6	5	4.5	4.5	5	6	5	5	5	5	8	6	4	5	8	0.458
ANSI	6	7	6	6	6	7	7	6	6	6	8	7	7	6	9	7	0.536
HB	7	5	7	7	7	6	5	9	9	7	6	4	5	8	8	4	0.542
JIS	8	11	12	9	9	8	9	12	12	12	12	5	4	2	4	2	0.682
GB	9	8	11	8	8	9	8	11	11	11	11	1	1	3	2	3	0.604
DIN	10	9	8	11	11	10	10	7	10	10	10	6	8	7	6	6	0.724
NF	11	10	9	11	11	11	11	8	7	8	7	3	2	1	7	5	0.641
BS	12	12	10	11	11	12	12	10	8	9	9	2	3	5	3	9	0.724

The rank sum ratio RSR values in the rank table of each index are arranged from small to large, and the corresponding cumulative frequency is calculated. Then, Y is obtained by referring to the percentage and probit comparison table.

Table 4. RAR and probit Y.

RSR	f	f↓	R	R	P	Y
0.313	2	2	1-2	1.5	12.5%	3.85
0.393	1	3	3	3.0	25.0%	4.33
0.409	1	4	4	4.0	33.3%	4.59
0.458	1	5	5	5.0	41.7%	4.79
0.536	1	6	6	6.0	50.0%	5.00
0.542	1	7	7	7.0	58.3%	5.21
0.604	1	8	8	8.0	66.7%	5.43
0.641	1	9	9	9.0	75.0%	5.67
0.682	1	10	10	10.0	83.3%	5.97
0.724	2	12	11-12	11.5	97.9%	6.39

Pearson correlation analysis of RSR and Y was carried out by Eviews software. The results showed that RSR had a significant positive correlation with Y ($r=0.980$，$P<0.01$). RSR and Y were used to fit the regression line: $RSR=-0.356+0.173Y$.

Table 5. Regression analysis result table of RSR and Y.

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	-0.35629	0.044449	-8.015731	0.0000
Y	0.173044	0.008589	20.147600	0.0000
R-squared	0.980673	Mean dependent var		0.530208
Adijusted R-squared	0.978257	S.D.dependent var		0.135143
S.E. of regression	0.019927	Akaike info criterion		-4.816576
Sum squared resid	0.003177	Schwarz criterion		-4.756059
Log likelihood	26.08288	Hannan-Quinn criter		-4.882963
F-statistic	405.9259	Durbin-Watson stat		1.697051
Prob(F-statistic)	0.000000			

The determining coefficient R2 of the regression equation is equal to 0.980, and the residual error is normally distributed, indicating that the linear equation is well fitted. The regression coefficient was 0.173, and the effect of Y on RSR was statistically significant.

2.5. Result

According to the optimal segmentation method, the value of RSR is divided into 3 classes by the probability unit value, and the results of each grade are as follows.

Table 6. Result table of ISO organization influence.

Class	P	Y	Range of RSR	Standard Organization	Value of RSR
small	<P15.866	<4	0.357	ASTM	0.313
				UL	0.313
medium	>P15.866	>4	>0.357	ASME	0.393
				IEC	0.409
				IEEE	0.458
				ANSI	0.536
				HB	0.542
				GB	0.604
				NF	0.641
				JIS	0.682
big	>P84.134	>6	>0.645	BS	0.724
				DIN	0.724

Thus, the results of ISO standard influence on 12 standardization organizations based on adoption relationship can be obtained. The higher the RSR score should have the greater the influence of ISO standard on the standardization organization. From the result table, we could find that ISO standard organization has the greatest influence on German standard (DIN) and British standard (BS). Next, the medium influence, are Japanese standard (JIS), French standard (NF), Chinese standard (GB, HB), American standard ANSI and ASME, international standard organization IEEE and IEC. The last class is small influence from ISO, it includes two organization from England and America. They are UL and ASTM which have the same value of RSR.

3. Conclusion

We do the research of the influence of ISO standard organization by RSR method. The 12 standard organizations from Asian, Europe, America and international organizations. We found that the ISO has relatively large influence with Europe standard organization. The second is Asian, JIS and GB are the third and fifth in the RSR scores respectively. The three organization in the America scored big

different. The highest score of them is belongs to medium ISO influence class. The two international organizations, IEEE and IEC, have the similar RSR value and are ranked seventh and eighth.

In order to study standardization better, this paper starts from ISO influence and give the results of 12 organization. We will continue to study it from other aspects in the future research.

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