

Qualification Evaluation of Computer Information System Integration Based on Weighted Products

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Abstract Focus on the process of computer information system integration qualification review, the existing partial defects is analysis. With the index analysis and resolution, the 7 major categories of indicators separate into quantifiable index. Based on the compensability analysis between indexes, new evaluation method which different level should use weighted products or weighting plus is put forward. Finally, with actual data collection and calculation, a satisfied evaluation result is get. It is a new method for government, evaluation mechanism and integrated enterprise.

Keywords system integration enterprise; qualification evaluation; weighted products; software industry

After the 2008 financial crisis, the global software industry recovered to enter a new stage of development^[1]. Along with our country's "Two-oriented Integration", "Software City"^[2], "Nuclear high-based projects", etc. Those policies promote the development of the industry, the domestic software industry rapid growth on a roll. In our country, the index reflect the status of the software industry development mainly includes the quantity and quality of software enterprises and software product quality, software park, etc., and reflects the level of software enterprise factors is usually enterprise scale, enterprise income, the internationalization level, qualifications etc.^[2]. Our country software enterprise level evaluation depends on two times a year, our country's system integration enterprise qualification certification, qualification that define the conditions and level of the system integration enterprise, and directly reflects the development of software industry in our country.

1 System integration qualification and assessment system

The so-called system integration is a new process and method which combines different systems into an integrated, more powerful new one, depending on the application needs. Computer

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Information System Integration is engaged in the overall planning, design, development, implementation, service and protection of computer application system engineering and network system engineering. The Qualification Certification of Computer Information System Integration refers to the process in which those companies of computer information system integration must go through the certification held by third-party certification organizations, which are authorized by the Ministry of Industry and Information Technology Ministry, in order to obtain the “Computer Information System Integration Qualification Certificate”. These third-party certification organizations will assess the comprehensive and integrated capabilities of these enterprises on computer information systems, including technical level, management level, service level, quality assurance capabilities, technical equipment, system construction quality, personnel ratios and quality^[3], operation results, assets condition and other factors^[4].

At present, system integration enterprises of China can be divided into four levels — first grade enterprises have the capacity to build computer information system of those national, provincial (ministry), industrial level, prefectural (city and below) level enterprises independently, including large, medium and small ones and other types; second grade enterprises have the capacity to build computer information system of those provincial (ministry), industrial level, prefectural (city and below) level enterprises independently, including large, medium and small ones and other types; third grade enterprises have the capacity to build computer information system of those medium and small enterprises independently, or cooperative with the large-scale enterprises (or equivalent size ones); forth grade enterprises have the capacity to build computer information system of those small enterprises independently, or cooperative with the midsize enterprises (or equivalent size ones)^[5].

Assessments of all grades of enterprises have strict evaluation criteria, such as first grade qualification selection criteria are divided into seven categories, consisting of 27 rules. See the first and second column of Table 1.

Table 1 Evaluation criteria of first grade enterprise of computer information system

Fist-grade Index	Second-grade Index	Index Analysis
General Conditions (I)	Time for Business entities with clear property rights, registered in China, to obtain second-grade qualification is no less than two years (I ₁)	Business entities registered in China (I _{1,1})
		Clear property rights (I _{1,2})
		Time to obtain second-grade qualification is no less than two years (I _{1,3})
	With no qualification of supervision on information system engineering (I ₂)	
	System integration income is no less than 70% of the total operating income (I ₃)	
	Both registered capital and paid-up capital are no less than 50 million yuan (I ₄)	Registered capital is no less than 50 million yuan (I _{4,1})
		Paid-up capital is no less than 50 million yuan (I _{4,2})

Continued Table 1

Financial Situation (F)	The gross income of system integration is no less than 500 million yuan (or no less than 400 million yuan with the software and information technology services fee no less than 80% of it); make sure financial data real and audited by accounting firms (F ₁)	The gross income of system integration is no less than 400 million yuan (F _{1,1})
		The software and information technology services fee ratio is no less than 80% (F _{1,2})
		Financial data is real and audited by accounting firms (F _{1,3})
	No loss (F ₂)	
	Own fixed and intangible assets compatible with its business (F ₃)	
Credit (C)	No act violating state laws or regulations (C ₁)	
	No sale or provision of non-genuine software (C ₂)	
	No unacceptable project or major complaints from users which the enterprise should be mainly responsible for (C ₃)	All projects have passed the acceptance check (C _{3,1})
		No major complaints from users which the enterprise should be mainly responsible for (C _{3,2})
	No illicit competition (C ₄)	
Performance (P)	No bad behavior in the application for qualification and the use of the certificate (C ₅)	
	Have completed system integration projects of no less than 2 million yuan, pure software and information technology services of no less than 1 million yuan, and total amount of no less than 400 million yuan (or no less than 350 million yuan with the software and IT services fee ratio no less than 80%). These projects involve at least three provinces (autonomous regions or municipalities), and have passed the acceptance check (P ₁)	Have completed system integration projects of no less than 2 million yuan (P _{1,1})
		Pure software and information technology services of no less than 1 million yuan (P _{1,2})
		The software and IT services fee ratio no less than 80% (P _{1,3})
		Projects involve at least three provinces (autonomous regions or municipalities) (P _{1,4})
		Projects have passed the acceptance check
	At least four contracts are not less than 15 million yuan, or, or complete the contract of system integration projects of no less than 10 million yuan with the total amount no less than 60 million yuan, or complete the contract of pure software and IT services of no less than 5 million yuan with the total amount no less than 30 million yuan, and at least some of the projects adopt those software products created on their own (P ₂)	At least four contracts are not less than 15 million yuan (P _{2,1})
		Complete the contract of system integration projects of no less than 10 million yuan with the total amount no less than 60 million yuan (P _{2,2})
		Complete the contract of pure software and IT services of no less than 5 million yuan with the total amount no less than 30 million yuan (P _{2,3})
		At least some of the projects adopt those software products created on their own (P _{2,4})

Continued Table 1

	The software and information technology services fee ratio of the project is no less than 30%, or the software and IT service fee is no less than 120 million yuan, or the total fee of software development is no less than 65 million yuan (P ₃)	The software and information technology services fee ratio of the project is no less than 30% (P _{3,1})
		The software and IT service fee is no less than 120 million yuan (P _{3,2})
		The total fee of software development is no less than 65 million yuan (P _{3,3})
Management Ability (M)	Quality management system have passed the acceptance check by a Nationally recognized third-party certification organization, and have kept an continuous effective running for no less than one year (M ₁)	Quality management system have passed the acceptance check by a Nationally recognized third-party certification organization (M _{1,1})
		Have kept an continuous effective running for no less than one year (M _{1,2})
	Use management tools for project management, and can effectively implement (M ₂)	
	Complete customer service system (M ₃)	
	Perfect enterprise management information system, and can effectively run (M ₄)	
	Principal head should have at least five years' experience of business management in the field of information technology; the main technical director should have the senior project manager qualification of the Computer Information System Integration or senior technical title of electronic information, and has work experience of no less than 5 years in the field of system integration technology; the chief financial officer should have senior professional title on finance (M ₅)	Principal head should have at least five years' experience of business management in the field of information technology (M _{5,1})
		The main technical director should have the senior project manager qualification of the Computer Information System Integration (M _{5,2})
		The main technical director has senior technical title of electronic information (M _{5,3})
		The main technical director has work experience of no less than 5 years in the field of system integration technology (M _{5,4})
		The chief financial officer should have senior professional title on finance (M _{5,5})
Technical Strength (T)	Typical project technology is at leadership position in the same domestic industry (T ₁)	
	On independent intellectual property based business software platforms or other advanced development platform, there are no less than 20 registered independent software products, among which no less than 10 of them were registered in the last three years, and some of these software products have been applied in practice in the last three years (T ₂)	Independent intellectual property based business software platforms or other advanced development platform (T _{2,1})
		no less than 20 registered independent software products (T _{2,2})
		no less than 10 of software products were registered in the last three years (T _{2,3})
		some of these software products have been applied in practice (T _{2,4})

Continued Table 1

Human Re-sources (H)	Have specialized technology leaders I6; establish a complete software development and testing system I7; R&D and office space area is no less than 1500 square meters (T ₃)	Have specialized technology leaders (T _{3,1}) a complete software development and testing system (T _{3,2}) R&D and office space area is no less than 1500 square meters (T _{3,3})
	Own R&D management system (T ₄)	
	Relevant technical staff number is no less than 220, among which the proportion of people with bachelor's degree or above is no less than 80% (H ₁)	Relevant technical staff number is no less than 220 (H _{1,1}) The proportion of people with bachelor's degree or above is no less than 80% (H _{1,2})
	Staff with project management qualification is no less than 30 people, senior project manager number is no less than 10 (H ₂)	Staff with project management qualification is no less than 30 people (H _{2,1}) Senior project manager number is no less than 10 (H _{2,2})
	Comprehensive human resource management system (H ₃)	

Data sources: Grading Criteria for Computer Information System Integration Enterprise Qualification (2012 revised edition).

From the first and second column of Table 1 it can be seen that the content of the table has too many connotations, so the index analysis is necessary. Then the results are shown in the third column of Table 1 clearly.

2 Evaluation methods of system integration qualification

The evaluation processes of Enterprise System Integration Qualification are basically similar in China, but slight differences can still be found, for example, first grade enterprise qualification assessment process consists of four links, as shown below.

The third-party accrediting organization holds the document review and on-site evaluation, and verifies the enterprise application materials. → Ministry of Industry and Information Technology holds expert review meeting and the enterprise defense for itself. → Experts will vote according to the defense situation and application materials provided by the enterprise. → Report to the qualification management committee based on the voting results.

This evaluation method is essentially a combination of repeated and complex on-site manual work by assessors and qualitative voting by experts. Primarily, the evaluation result depends on the assessment experience and work attitude of those assessors. Secondly, it depends on the on-site defense effect. And finally, it is decided by experts' intuitive feelings toward the status of the enterprise. Therefore, this evaluation method has some disadvantages — lack of fair, impartial and scientific assessment principles, and thus there is always dispute or disagreement on the evaluation results. A conclusion can be drawn that to explore the scientific and rational evaluation method is an vital issue in the face of government policy makers of China's software industry, system integration enterprises, as well as qualification assessors.

Lots of evaluation methods are currently used. For the qualitative ones, there are expert-

group method, Delphi method^[6], brainstorming, etc. For the quantitative ones, there are weighted sum method, lexicographic method, AHP, the weighted product method, TOPSIS method, the main component analysis^[7], etc. Besides, there is a fuzzy comprehensive evaluation method, which is the combination of qualitative and quantitative method^[8], as well as extension goodness method^[9–10] and so on. Selection of methods generally depends on the nature of the problem. These methods all have their own advantages, but they also have some shortcomings and assumptions. For example, the weighted sum method, the most widely used method, includes the following assumptions^[11]:

- ① Index system appears to be a tree structure, in which each subordinate only associates with its upper index;
- ② The marginal value of each index is linear (the pros and cons is proportional to index value), the value of each two index are mutually independent;
- ③ The indexes are fully compensatory, that is, no matter how poor a certain index of a program is, it can be compensated by another index.

In fact, this assumption is not true in some evaluations. First, the index system may be reticulated, i.e., at least one subordinate associates with two or more than two upper indexes simultaneously. That is, an indicator can reflect both extents of the two upper indexes. Secondly, the linear condition of the marginal value of each index is often local, and there may be even a best value for a given interval or the midpoint; value independence conditions between indexes are also extremely difficult to meet, or at least extremely difficult to verify whether they meet. While compensatory between the indexes is usually only partial and conditional.

Unlike weighted sum method, the weighted product method has the following obvious characteristics: as long as there is a group (or class) indexes of which the value are zero, the comprehensive evaluation index of the weighted product method is zero; as long as there is a group (or class) indexes of which the values are lower, it will greatly affect the final value of the program; thus non-compensatory of indexes have been fully reflected.

During the system integration qualification evaluation process, a certain amount of compensatory can be reached between the first-grade indexes since each enterprise has its own characteristics and development process. From the second-grade indexes, it can be known that each enterprise should be compared with each other horizontally. Each condition must be met by the enterprises indispensably, so there cannot be compensatory between the first-grade and second-grade indexes. Even if there is partial compensation, it can not be linear, which is precisely the thought and meaning of the weighted product method. Therefore, in order to achieve fair, scientific and rational qualification evaluation results, a comprehensive evaluation method should be adopted.

1) The relationship between the second-grade index and index analysis

The split of second-grade index is intended to analyze the problem, evaluate, and collect data conveniently. The relationship between second-grade index and index analysis are various. Some are the weighted product, some are weighted sum, and some are disjunction. Through the understanding of the index, the following relationship can be obtained:

$$I_1 = I_{1,1} \times I_{1,2} \times I_{1,3},$$

$$I_4 = I_{4,1} \times I_{4,2},$$

$$F_1 = \begin{cases} F_{1,1} \times F_{1,3} & F_{1,1} \geq 5 \\ (F_{1,1} \vee F_{1,2}) \times F_{1,3} & 4 \leq F_{1,1} < 5 \\ 0 & F_{1,1} < 4 \end{cases},$$

$$C_3 = C_{3,1} \times C_{3,2},$$

$$P_1 = \begin{cases} (P_{1,1} + P_{1,2}) \times P_{1,4} \times P_{1,5} & F_{1,1} \geq 4 \\ (P_{1,1} + P_{1,2}) \times P_{1,3} \times P_{1,4} \times P_{1,5} & 3.5 \leq F_{1,1} < 4 \\ 0 & F_{1,1} < 3.5 \end{cases},$$

$$P_2 = (P_{2,1} \vee P_{2,2} \vee P_{2,3}) \times P_{2,4},$$

$$P_3 = P_{3,1} \vee P_{3,2} \vee P_{3,3},$$

$$M_1 = M_{1,1} \times M_{1,2},$$

$$M_5 = M_{5,1} \times (M_{5,2} \vee M_{5,3}) \times M_{5,4} \times M_{5,5},$$

$$T_2 = I_{2,1} \times T_{2,2} \times T_{2,3} \times T_{2,4},$$

$$T_3 = I_{3,1} \times T_{3,2} \times T_{3,3},$$

$$H_1 = H_{1,1} \times H_{1,2},$$

$$H_2 = H_{2,1} \times H_{2,2}.$$

2) The relationship between first-grade and second-grade indexes

The first-grade indexes are divided into a plurality of many second-grade indexes, while all contents of the second-grade indexes reflect connotations of the first-grade indexes. These second-grade indexes are required to meet all standards. They do not have compensatory, reflecting the thought of weighted product, namely:

$$I = \prod_{i=1}^4 I_i, \quad F = \prod_{i=1}^3 F_i, \quad C = \prod_{i=1}^5 C_i, \quad P = \prod_{i=1}^3 P_i, \quad M = \prod_{i=1}^5 M_i, \quad T = \prod_{i=1}^4 T_i, \quad H = \prod_{i=1}^3 H_i.$$

3) The comprehensive assessment of the first-grade index

The comprehensive assessment score of each first-grade index is the final score of each enterprise. According to different consideration, each first-grade index can be set a weight $\omega_j, j = 1, 2, \dots, 7$, while since there is a certain compensatory between each index, the final score of each enterprise is: $A_i = \sum_{j=1}^7 \omega_j x_{ij}, j = 1, 2, \dots, 7$, of which $x_j = I, F, C, P, M, T, H$, apparently using the weighted sum method.

3 System integration qualification index assignment

Scientific and fair evaluation process depends on the data. The nature, range, and standard requirements of various indexes related to the review process for the System Integration Qualification can be expressed in Table 2.

Table 2 The nature, range, and standard requirements of evaluation indexes

Index Name	Index Nature	Index Range	Index Standard
Business Entity(I _{1,1})	Qualitative Logic	Domestic, Non-domestic	Domestic
Property Relations(I _{1,2})	Qualitative Logic	Clear, not Clear	Clear
Second-grade Qualification Time(I _{1,3})	Qualitative Logic	[0, ∞)	≥ 2
Supervision Qualification(I ₂)	Qualitative Logic	Yes, No	No
System Integration Income Ratio(I ₃)	Quantitative Benefits	[0,1]	≥ 70
Registered Capital(I _{4,1})	Quantitative Benefits	[0, ∞)	≥ 5000 Million Yuan
Paid-in Capital(I _{4,2})	Quantitative Benefits	[0, ∞)	≥ 5000 Million Yuan
Integration Income Amount(F _{1,1})	Quantitative Benefits	[0, ∞)	≥ 4000 Million Yuan
The Proportion of Software and Information Services(F _{1,2})	Quantitative Benefits	[0,1]	≥ 80
Financial Audit(F _{1,3})	Qualitative Benefits	Credible, not Credible	Credible
Financial Situation(F ₂)	Qualitative Logic	No Loss, Loss	No Loss
Fixed Assets and Intangible Assets(F ₃)	Qualitative Benefits	Yes, No	Yes
Laws and Regulations(C ₁)	Qualitative Logic	No Offense, Offense	No
None-genuine Software(C ₂)	Qualitative Logic	Yes, No	No
Project Acceptance(C _{3,1})	Qualitative Logic	Pass, not Pass	Pass
Users' Major Complaint(C _{3,2})	Qualitative Logic	Yes, No	No
Participation of Unfair Competition(C ₄)	Qualitative Logic	Yes, No	No
Poor Record on Reporting and Certificate(C ₅)	Qualitative Logic	Yes, No	No
Projects of More Than 200 Million Yuan(P _{1,1})	Quantitative Benefits	$P_{1,1} + P_{1,2} \in [0, \infty)$	3.5
Pure Soft Projects of More Than 100 Million Yuan(P _{1,2})	Quantitative Benefits		
The Proportion of Pure Soft Projects(P _{1,3})	Quantitative Benefits	[0,1]	≥ 80
Project Regions(P _{1,4})	Quantitative Benefits	[0,31]	≥ 3
Project Acceptance(P _{1,5})	Qualitative Logic	Pass, not Pass	Pass
15-Million-Yuan Project Amount(P _{2,1})	Quantitative Benefits	[0, ∞)	≥ 4
10-Million-Yuan Integration Project Amount(P _{2,2})	Quantitative Benefits	[0, ∞)	≥ 60 Million Yuan
5-Million-Yuan Pure Soft Project Amount(P _{2,3})	Quantitative Benefits	[0, ∞)	≥ 30 Million Yuan

Continued Table 2

Index Name	Index Nature	Index Range	Index Standard
Application of Self-developed Software Products(P _{2,4})	Qualitative Benefits	A Lot, General, A Few	A Few
Proportion of Software and Information Service Fee(P _{3,1})	Quantitative Benefits	[0,1]	≥ 30
Total Amount of Software and Information Service Fee(P _{3,2})	Quantitative Benefits	[0, ∞)	≥ 120 Million Yuan
Total Amount of Software Development(P _{3,3})	Quantitative Benefits	[0, ∞)	≥ 65 Million Yuan
Quality Management System(M _{1,1})	Qualitative Logic	Pass, not Pass	Pass
Continuous Operation Time of Quality Management System(M _{1,2})	Quantitative Benefits	[0, ∞)	≥ 1
Management Tools Implementation(M ₂)	Qualitative Benefits	Excellent, Good, Fair, Poor	Good
Customer Service System(M ₃)	Qualitative Benefits	Excellent, Good, Fair, Poor	Good
Management Information System(M ₄)	Qualitative Benefits	Excellent, Good, Fair, Poor	Good
IT Experience of the Principal Head	Quantitative Benefits	[0, ∞)	≥ 5
Main Technical Director Qualification(M _{5,2})	Qualitative Benefits	Project Manager, Senior Project Manager	Senior Project Manager
Technical Title of the Main Technical Director(M _{5,3})	Qualitative Logic	Primary, Intermediate, Senior	Senior
Time of the Main Technical Director in Charge of Technical Work(M _{5,4})	Quantitative Benefits	[0, ∞)	≥ 5
Title of the Chief Financial Officer(M _{5,5})	Qualitative Logic	Primary, Intermediate, Senior	Senior
Level of Typical Project Technology(T ₁)	Qualitative Benefits	Domestic, Asian, International	Domestic
Intellectual Property Right Software Platform(T _{2,1})	Qualitative Logic	Yes, No	Yes
Self-developed Software Products Registration(T _{2,2})	Quantitative Benefits	[0, ∞)	≥ 20
Registration Number in the Last 3 Years(T _{2,3})	Quantitative Benefits	[0, ∞)	≥ 10
Software Products Application(T _{2,4})	Qualitative Benefits	Excellent, Good, Fair, Poor	Good
Technology leaders(T _{3,1})	Qualitative Logic	Yes, No	Yes

Continued Table 2

Index Name	Index Nature	Index Range	Index Standard
Software Development Test System($T_{3,2}$)	Qualitative Logic	Yes, No	Yes
R&D and Office Space($T_{3,3}$)	Quantitative Benefits	$[0, \infty)$	$\geq 1500m^2$
R&D Management System	Qualitative Logic	Yes, No	Yes
Technical Staff Number($H_{1,1}$)	Quantitative Benefits	$[0, \infty)$	≥ 220
Proportion of Technical Staff with Bachelor's Degree or Above($H_{1,2}$)	Quantitative Benefits	$[0,1]$	$\geq 80\%$
Number of Project Management Qualification($H_{2,1}$)	Quantitative Benefits	$[0, \infty)$	≥ 30
Senior Project Manager Number($H_{2,2}$)	Quantitative Benefits	$[0, \infty)$	≥ 10
Human Resource Management System(H_3)	Qualitative Benefits	Excellent, Good, Fair, Poor	Good

4 Case application

Take four companies (N_1, N_2, N_3, N_4), which participated qualification evaluation in the first half of 2012, to illustrate the data extraction and calculation in the entire evaluation process.

Table 3 Case data

Index	$I_{1,1}$	$I_{1,2}$	$I_{1,3}$	I_2	I_3	$I_{4,1}$	$I_{4,2}$	$F_{1,1}$	$F_{1,2}$	$F_{1,3}$	F_2	F_3	C_1	C_2
N_1	Domestic	Clear	2	No	75	9000	8640	4.3	82%	Credible	No	Yes	No	No
N_2	Domestic	Clear	2	No	82	8000	7100	5.7	40%	Credible	No	Yes	No	No
N_3	Domestic	Clear	2	No	77	5000	5300	5	70%	Credible	No	Yes	No	No
N_4	Domestic	Clear	2.5	No	73	6000	6200	5.5	70%	Credible	No	Yes	No	No

Index	$C_{3,2}$	C_4	C_5	$P_{1,1}$	$P_{1,2}$	$P_{1,3}$	$P_{1,4}$	$P_{1,5}$	$P_{2,1}$	$P_{2,2}$	$P_{2,3}$	$P_{2,4}$	$P_{3,1}$	$P_{3,2}$
N_1	No	No	No	0.5	3.1	0.861	6	Pass	3	6500	2700	General	40	1.1
N_2	No	No	No	1.9	3.3	0.635	3	Pass	4	7200	2200	A Few	35	1.7
N_3	No	No	No	2.1	2	0.488	4	Pass	5	8600	2260	General	32	0.9
N_4	No	No	No	1.1	3.4	0.756	5	Pass	5	9200	1750	A Few	41	1.4

Index	$P_{3,3}$	$M_{1,1}$	$M_{1,2}$	M_2	M_3	M_4	$M_{5,1}$	$M_{5,2}$	$M_{5,3}$	$M_{5,4}$
N_1	7000	Pass	2	Excellent	Good	Excellent	5	Senior	Intermediate	5
N_2	7200	Pass	1	Good	Excellent	Good	7	Senior	Senior	7
N_3	6500	Pass	3	Good	Excellent	Excellent	9	Senior	Senior	6
N_4	6300	Pass	1	Excellent	Good	Excellent	10	Intermediate	Senior	5

Continued Table 3

Index	M _{5,5}	T ₁	T _{2,1}	T _{2,2}	T _{2,3}	T _{2,4}	T _{3,1}	T _{3,2}	T _{3,3}	T ₄	H _{1,1}	H _{1,2}	H _{2,1}	H _{2,2}	H ₃
N ₁	Senior	Domestic	Yes	35	12	Good	Yes	Yes	1500	Yes	270	82%	36	11	Good
N ₂	Senior	Domestic	Yes	21	10	Good	Yes	Yes	1800	Yes	260	80%	35	10	Excellent
N ₃	Senior	Domestic	Yes	22	16	Good	Yes	Yes	2500	Yes	300	80%	32	12	Good
N ₄	Senior	Domestic	Yes	36	11	Good	Yes	Yes	2200	Yes	240	96%	30	10	Good

Note: Without special instructions, the index data in this table is only taken from the last three years.

The second-grade index can be calculated through the relationship between the second-grade index and index analysis. Yet one thing should be noted that since there are incommensurability between various indexes, and the dimension difference as well, each index should be normalized and converted to a number between 0 and 1, wherein the quantitative data calculated by benchmarking.

Namely, Benefit-oriented Index takes $Z_{ij} = x_{ij}/x_i^{\max}$, while Cost-oriented Index $Z_{ij} = x_i^{\max}/x_{ij}$; Qualitative logic index takes 0 and 1; third-grade qualitative index takes 1, 0.75, and 0.5; forth-grade qualitative index takes 1, 0.75, 0.5, and 0.25.

Normalized results are shown in Table 4.

Table 4 Case data processing

Index	I ₁	I ₂	I ₃	I ₄	F ₁	F ₂	F ₃	C ₁	C ₂	C ₃	C ₄	C ₅	P ₁	P ₂
N ₁	0.8	1	0.75	1	0.829	1	1	1	1	1	1	1	0.913	0.53
N ₂	0.8	1	0.82	0.731	1	1	1	1	1	1	1	1	0.5	0.4
N ₃	0.8	1	0.77	0.341	0.877	1	1	1	1	1	1	1	0.539	0.75
N ₄	1	1	0.73	0.479	0.965	1	1	1	1	1	1	1	0.721	0.5

Index	P ₃	M ₁	M ₂	M ₃	M ₄	M ₅	T ₁	T ₂	T ₃	T ₄	H ₁	H ₂	H ₃
N ₁	0.976	0.667	1	0.75	1	0.357	1	0.547	0.6	1	0.769	0.917	0.75
N ₂	1	0.333	0.75	1	0.75	0.7	1	0.273	0.72	1	0.722	0.81	1
N ₃	0.903	1	0.75	1	1	0.771	1	0.458	1	1	0.833	0.889	0.75
N ₄	1	0.333	1	0.75	1	0.714	1	0.516	0.88	1	0.8	0.694	1

Suppose further that seven categories of the first-grade index are the same on weights, the comprehensive evaluation value of each enterprise will be: $N_1 = 0.562$, $N_2 = 0.513$, $N_3 = 0.578$, $N_4 = 0.552$, that is, $N_3 \succ N_1 \succ N_4 \succ N_2$.

5 Conclusion

The evaluation of system integration qualification enterprise is significant towards our domestic software and information services industry, and it is also driving force to promote the steady development of China's software and information service industry. This paper have reached a reasonably satisfactory result through the analysis of indexers, and the integrated use of selection criteria at different levels, combining the weighted product and weighted sum

method to evaluate enterprise qualification. The idea and method proposed in this paper can help the government departments guide the development of the industry effectively with administrative means, thus carry out fair and impartial evaluation; At the same time, it will help reduce the repeatability workload of assessors from evaluation agencies, streamline workflow, and improve work efficiency; It will also help system integration enterprises to identify the development direction and standardize their development paths.

It should be noted that the paper showed the advantage of N_3 obviously, while little difference can be found between N_1 and N_4 in this evaluation. Therefore, before the passing number of the qualified enterprises is decided, differences in the evaluation results should be taken into consideration. To select the best from those excellent, N_3 , N_1 and N_4 three companies should pass the evaluation in this case. It is unreasonable if only the N_3 and N_1 are allowed to pass the evaluation, after all the difference between N_1 and N_4 is quite small. Therefore, the evaluation results of the system integration enterprise group should be further analyzed with the help of aggregative rank^[12–14] idea, which is one of the directions for further paper research.

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