IT outsourcing service provider dynamic evaluation model and algorithms based on Rough Set

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Abstract

The traditional supplier evaluation methods mostly belong to the static evaluation, and the actual information service provider selection is a dynamic process, need to use dynamic evaluation method to measure. In order to select the IT outsourcing service provider, the tool which uses complex scientific management system-thinking - Exploration diagram, established the index system for the selection of IT outsourcing. Based on it, the decision table of dynamic IT-Outsourcing service provider selection is made. The decision rule set of IT outsourcing service provider prediction is obtained by applying rough set theory of the decision table attribute reduction and value reduction. Finally, a calculation example of IT outsourcing service provider selection is illustrated，which shows that the mentioned evaluation method is feasible and efficient for dynamic IT outsourcing service provider selection and prediction. Thus, it supplies reasonable analysis and policy making of IT outsourcing service provider.

Keywords: *IT outsourcing; Service evaluation; Exploration diagram; reduction; rules gaining*

1. Introduction

With the development of Information Technology and thinking of outsourcing, enterprise and researcher pay more attention on the IT outsourcing. Domestic and foreign scholars from different angles on information technology outsourcing are discussed. The information technology outsourcing is a new management method and it will be an effective way for all middle and small scale enterprises to realize informationization. Currently, 60% of U.S. companies with professional IT outsourcing services rapidly expand their own business [1-2]. However, IT outsourcing is a very complex business processes and accompanied by a variety of risks, results show that IT outsourcing success is still to be improved. Among them, the one of the greatest risks is the selection of service providers. [3].

The traditional supplier evaluation methods mostly belong to the static evaluation, and the actual information service provider selection is a dynamic process, need to use dynamic evaluation method to measure. There is no unified framework of IT outsourcing service provider evaluation index system in the present study. And evaluation is often focused on the current situation, unable to evaluate the future continuous development of IT outsourcing service provider.

So, exploration diagram tool is put forward in this paper, it use the complex scientific management system thinking mode to apply IT outsourcing service provider evaluation, absorb its systematic, modular and visual thinking ways of thinking [4-5]. Through this method, IT-outsourcing service provider evaluation of influence factors are found, and the evaluation index system is established. IT outsourcing service provider evaluation about an enterprise is taken as an example to set up the IT outsourcing service provider evaluation decision table, the decision table is conducted by applying rough set theory of the decision table attribute reduction and value reduction. And IT outsourcing service provider of the evaluation results decision rule set is obtained. According to it, the dynamic IT outsourcing service provider evaluation results and development trend are given. It provides the basis for enterprises to select the suitable IT outsourcing service provider.

2. Index System based on Exploration Diagram

Major Exploration diagram is the system thinking tool, which mainly helps to solve the problem of how to conduct visual thinking. Exploration diagram can help us to solve such kind of decision making problems: advance unknown, such as new product development decision-making, investment project evaluation and decision-making, through the creation of Exploration diagram to find all the factors that affects or may affect the research topic, helping to make decision.

Exploration diagram via the researchers to the whole environment of observation, according to own mastery of knowledge and information, plus full imagination, apply the point of bigger environment consideration to created a map. The picture presents all affects or may affect the

subject factors, at the same time, it also reflects the relationship of factors, and its formation is a collective creation process.

Exploration diagram use ellipse to represent factors, elliptic bidirectional arrow indicates interactive relationship, ruleless circles represent the same factors, and ligature used to connect factors of the same class, a tail on the ellipse indicates deleting factors. The process of drawing Exploration diagram for Evaluation of IT outsourcing service providers is as follows:

Step 1: According to the needs of the research theme or decision-making problems, the relevant experts convened to discuss the research topic or decision-making problems.

Step 2: Moderator or the responsible raise questions in accordance with the research topic or the question of the decision-making, allowing you to think .This article mainly discusses how to evaluate and select IT outsourcing service providers.

Step 3: Each member give full play to their imagination and express their views.

Step 4: After they have fully express their views, everybody are guided to conduct the visual think about all the proposed factors aimed at these oval, starting from the overall, integrated the same, Eliminate redundant, connect the factors of the same class with ligature, use the ruleless circles to enclose the same type factors, plus a tail in the oval for the deleted factors. the classified exploration diagram is shown in fig.1.

Step 5: To further the visual thinking, named each irregular circle, Such as commodity prices, types of goods, commodities performance, and Brand and commodity picture information can be classified as commodity information. The naming of this category is only an initial name, can eventually named after the analysis of the causal association.

Based on above, IT-outsourcing service provider selection index system is obtained and shown in table 1.
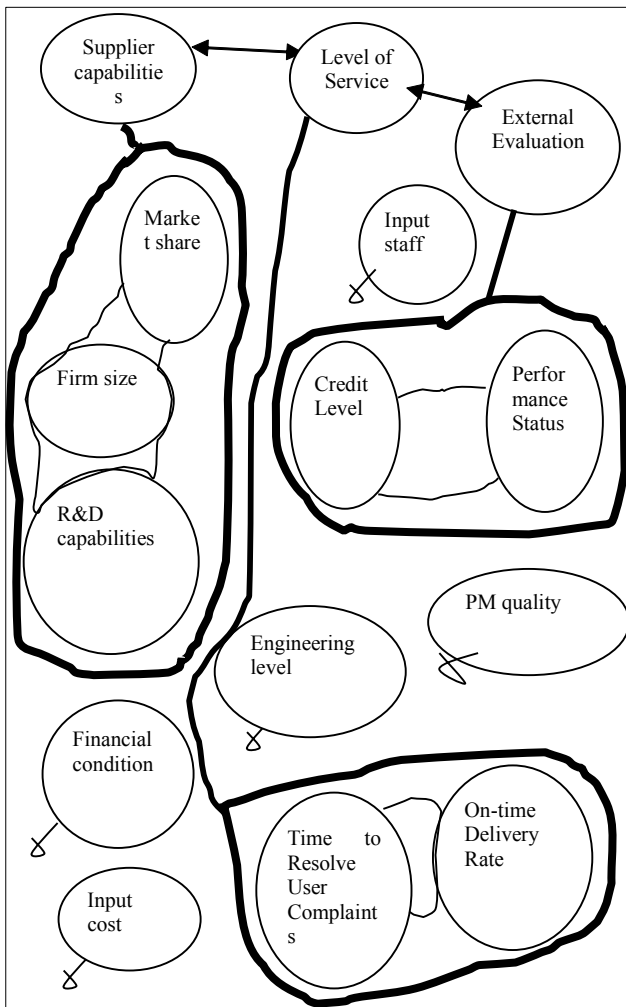

Fig. 1: classified exploration diagram

Table 1：IT-outsourcing supplier selection index system

Evaluation target	Factor indicators	Specific indicators	Character
IT-outsourcing supplier selection (A)	Supplier capabilities (B1)	Firm size (C1)	Quantitative
		R & D capabilities (C2)	Qualitative
		Market share (C3)	Quantitative
	Level of Service (B2)	On-time Delivery Rate (C4)	Quantitative
		Time to Resolve User Complaints (C5)	Quantitative
	External Evaluation (B3)	Credit Level (C6)	Qualitative
		Performance Status (C7)	Qualitative

3. Application of Rough Set Theory in IT Outsourcing Service Provider Evaluation

3.1 Rough Set Theory

Rough set theory [6-7] is a new mathematical tool to deal with imprecise, incomplete and inconsistent data. It can effectively analyze each kind of incomplete information such as imprecise, inconsistent, not integrity and so on, but also discovers the concealed knowledge and promulgates the latent rule according to analyzing and reasoning data.

In the rough set theory, computation of approximations and edge and attributes reduction of decision table is import part of them. Decision rules can be mined from given data using rough set theory. Comparing to others theories which processes indefinite and imprecise question, the most remarkable difference is it does not need outside the data acquisition which provides the question to examine the information, therefore it is quite objective to the indefinite description or processing questions. Because this theory has not been able to contain processing imprecise or indefinite primary data mechanism, so this theory and the theory of probability, the fuzzy mathematics and the evidence theory and so on other theory which processes indefinite or imprecise questions are complementary.

3.2 The Concepts of Rules Gaining

In this section we describe the concepts of rules gaining. Reducing the decision tables, searching the minimal attribute subsets and getting the succinct decision rules are not only the basic but also the toughest problems of Rough Set theory. The main idea of the theory of rough sets is to find out decision making and classification rules through knowledge reduction without changing the classification capacity of the information system.

The basic thought that discovers the classified rule in the decision support system based on rough set theory as follows:

Step1: the user proposes the duty of discover. The user takes some or many attributes as the classified policy-making attributes in the database, according to different values of these attributes, the data divides into the different category in the database, the duty of discover is produces these different determination rules.

Step2: using the algorithm based on rough set theory for gaining classification rules.

Some definitions are given follows:
Definition1: Discernibility Matrix [8-11].A mathematician named Skowron in Warsaw University proposes a discernibility matrix. There is a information system $S = (U, A, V, F)$, $U = \{x_1, x_2, ..., x_n\}$ is the universe of discourse, A is the attribute set, $A = C \cup D$, C is the condition attribute, D is the policy-making attribute, $a(x)$ is a value with x on the attribute a , the resolution matrix is

$$c(ij) = \begin{cases} a \in A : a(x_i) \neq a(x_j) & D(x_i) \neq D(x_j) \\ 0 & \phi & D(x_i) = D(x_j) \\ -1 & a(x_i) = a(x_j) & D(x_i) \neq D(x_j) \end{cases}$$

Definition 2: Equal Class. Regarding an attribute set $B \subset A$ in information system $S = (U, A, V, F)$, if it satisfies $IND(B) = \{(x, y) \in UXU \mid a(x) = a(y), \forall a \in B \}$, then equal relates $IND(B)$ called dual relates that can't distinguish each other. $B(x)$ express a equal class which object x in it.

Definition 3: CORE [9]. Opposite to attribute set D, core is an attribute set, which is intersect of reduction belongs to the attribute set C, records is CORE (C, D). The core is these attributes with its group divisible number is 1 in discernibility matrix.

Definition 4: Reduction [12]: U is the universe of discourse, R is an equal relational race, r ∈ R, $IND(R)$ is the intersect ion of equal relation in R, if $U / IND(R)$ is equal to $U / IND(R - \{r\})$, then r is may be canceled in R. Otherwise r is not be canceled in R. If any element in p ($P = R - \{r\}$) is not being canceled, then called P is the reduction of R.

Definition 5: Equal set description: if an equal set named E_i , then we descript its character by using $Des(E_i) = (a = v) . a \in A, v \in V_a$

Definition 6: Rules gaining [13]. Assume that the division of A in U is E , the division of A' is Y. E Look upon as the classification condition; Y looks upon as the classification conclusion. We may get classified rule as follows:

(1) If $E_i \cap Y_j \neq \phi$, then we get $r_{ij} : Des(E_i) \rightarrow Des(Y_j)$

　　a. If $E_i \cap Y_j = E_i$, then, the rule r_{ij} is ascertained. Rule confidence level is one ($cf = 1$).

　　b. If $E_i \cap Y_j \neq E_i$, then, the rule r_{ij} isn't ascertained.

Rule confidence level is $cf = \dfrac{|E_i \cap Y_j|}{|E_i|}$

(2) if $E_i \cap Y_j = \phi$, there isn't establish rule.

When the rule confidence level is one, this kind of rule can simplify. The rule reduction is that some attributes are deleted from condition attributes; the rule confidence level was still one.

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www.IJCSI.org

239

3.3 Model of IT Outsourcing Service Provider Evaluation based on Exploration Diagram and Rules Gaining

IT outsourcing service provider evaluation results can be divided into good, general, bad. According to the index system by applying explore diagram, selecting evaluation data of provider, using rough set theory to input space dimension reduction, completing input feature extraction work, it can achieve purpose: reduce the size of the data processing. The more sample data, the more the rules the higher reliability are. When the new supplier need to evaluation, using decision rule set, it can be evaluated. The whole procession is shown in Fig.2.

Now we describe the algorithm based on rough set for rules gaining.

Step 1: Foundation data processing. In this step, we need input $S = (U, A, V, F)$, then, according to given classification method, data are standardized.

Step 2: The smallest attributes set is obtained.
The algorithm as follows:

```
    Begin
        For i=1 to n
        For j=i to n
        M=[c(ij)]
```

$$/* \left(c(ij) = \begin{cases} a \in A & : a(x_i) \neq a(x_j) & D(x_i) \neq D(x_j) \\ 0 & \phi & D(x_i) = D(x_j) \\ -1 & a(x_i) = a(x_j) & D(x_i) \neq D(x_j) \end{cases} \right) */$$

```
        End for
        End for
        P={union of single attribute in M.}
    End
```

Step 3: Rules gaining and reducing. When attributes are reduced, we get a new policy-making table. First, equal sets of condition attributes and equal sets of policy attributes are obtained. Second, according to definition six, we can gain rules and reduce rules. At last, the same conclusions of rules are union.
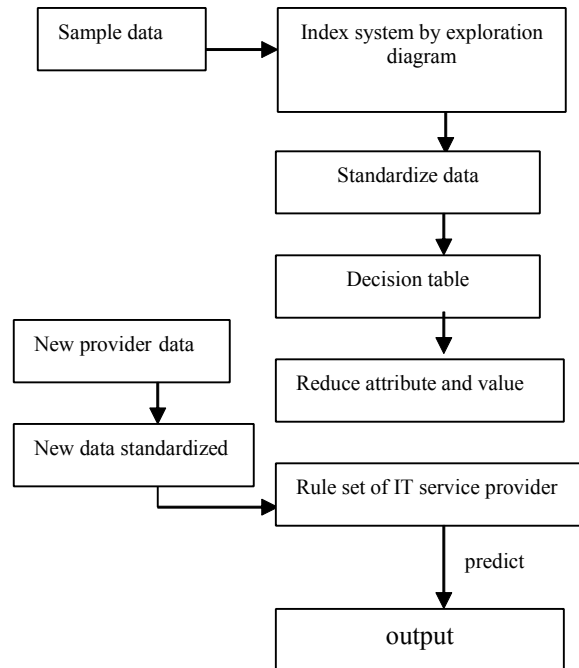

Fig. 2: The whole procession

4. Analysis of Example

In this section, an example in IT-outsourcing service provider selection is introduced to confirm the algorithm's validity. Suppose a company has ten IT-outsourcing service providers to be evaluated, we use model in section 3 to gain the rule and predict IT-outsourcing service providers.

Step 1: Foundation data processing. Each column of the attribute value is divided into three grades: 3-good, 2-general, 1-bad. The result is divided into three grades: 1-bad, 2-general, and 3-good. Table 2 is a dimension unitize policy-making table.

Table 2: Policy table

ID	C1	C2	C3	C4	C5	C6	C7	D
1	1	2	3	2	3	1	2	1
2	1	3	1	1	2	2	2	3
3	2	3	1	1	1	1	1	2
4	1	2	3	2	3	1	1	2
5	2	3	1	1	1	1	3	3
6	3	1	1	1	3	2	2	2
7	1	3	2	2	1	1	1	2

Step 2: Obtaining the smallest attributes set. According to definition three and step two from section 3, we use algorithm to calculate discernibility matrix M, and obtain the smallest attributes set P. In order to simply calculation,

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240

we use the computer programming to solve it. Program interface is shown in Fig.3. We can get $P = \{c1, c2, c7\}$. Table 3 is Policy-making table of reduction.
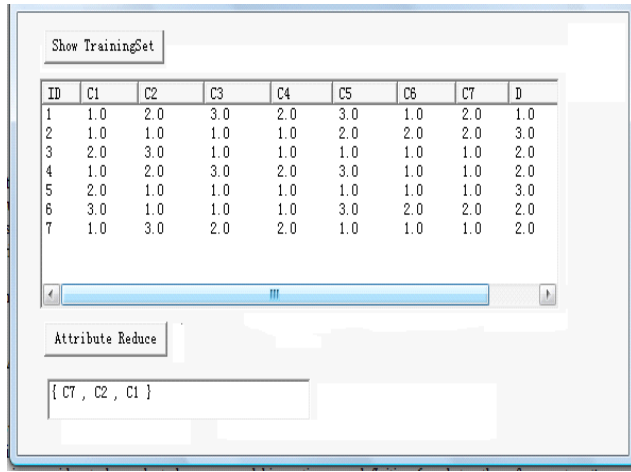

Fig.3: Program interface

Table 3: Policy-making table of reduction

ID	C1	C2	C7	D
1	1	2	2	1
2	1	3	2	3
3	2	3	1	2
4	1	2	1	2
5	2	3	3	3
6	3	1	2	2
7	1	3	1	2

Step 3: Rules gaining and reducing. According to definition 6 and step three from section 3, we can get the last policy.

When $cf = 1$, policy rules are below:

(1) $c_1 = 1 \wedge c_2 = 2 \wedge c_7 = 2 \rightarrow f_1$

(2) $c_7 = 1 \vee (c_1 = 3 \wedge c_2 = 1 \wedge c_7 = 2) \rightarrow f_2$

(3) $c_2 = 3 \vee (c_1 = 1 \wedge c_7 = 3) \rightarrow f_3$

The first rule shows that, if one service provider's firm size is bad, and R&D capability is general and performance status is general, we can deem this provider is bad, and rule confidence level is 1. The second rule shows that, if one service provider's performance status is bad, or firm size is good, and R&D capability is bad, and performance status is general, we can deem this provider is general, and rule confidence level is 1. The third rule shows that, if one service provider's firm size is bad, and R&D capability is good, or performance status is good, w can deem this provider is good, and rule confidence level is 1. When the new supplier need to evaluation, using decision rule set, it can be evaluated.

5. Conclusions

In the paper, according to the index system by applying explore diagram, selecting evaluation data of provider, using rough set theory to input space dimension reduction, completing input feature extraction work. An algorithm based on rough set for rules gaining is introduced to analyze and process data, minimal decision-making rules are proposed in IT outsourcing service provider selection. a calculation example of IT outsourcing service provider selection is illustrated，which shows that the mentioned evaluation method is feasible and efficient for dynamic IT outsourcing service provider selection and prediction.

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241

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