Study about Logistics Service Project Evaluation Based on Information Granularity of Rough Sets

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Abstract

Logistics service project evaluation is a key step in project management. The evaluation tasks are not only covered by the whole project process, but also are perceived by characteristic of logistics service. According to project management's hierarchical approach, we propose two evaluations in the theory of rough sets with different information granularities. So the decision maker can deal with multi-levels and multi-target by two series of rules. A case study is to support the hierarchical theory with the true data of one Third Part Logistics.

Keywords: Rough sets, Granularity theory, Attribute refiner, TPLs'project management.

1. Introduction

Logistics service project evaluation belongs to a multi-criteria decision making problem which includes both qualitative and quantitative factors. There are contradictory aspects of profit and loss in logistics service system. The most universal trade-off relation is Time-Quality-Cost. Furthermore, the special logistics projects emphasize this contradictory. On the condition of project management in logistics system, the direct reaction is to evaluate service project. We can appraise the process and result of project which had already been operated. The rules which come from history data, can improve decision-making quality, because the review of project's process includes both every step and millstones. Up to now, less effort has been made on project evaluation about data mining for logistics service. In this article, an integrated approach of hierarchy process improved by rough sets theory (RST) and Critical Path Method (CPM) is proposed to determine project evaluation. The evaluation tool is applied to controlling logistics projects. The remainder of this paper is organized as follows. The section 2 of this paper will discus how to establish information granularity of Rough Sets-based model. The section 3 promotes a case to study the evaluation system, which comes from one 3PL (Third Part Logistics) in China [1]-[3].

2. Rough set and information granularity theory

It is theoretically demonstrated that for any conditions attribute set, the finer the decision attribute value of a decision table is, the lower the information granularity. The more accuracy of approximation classification is, the better quality of approximation classification is. The section cites the relevant theory of Pawlak rough sets and information granularity theory [4]-[5].

2.1 Preliminaries

RST is based on an information system $S=(U,A,V,f)$. U is a finite set of reference actions, A *is* a finite set of attributes. $V=\bigcup_{a\in A} V_a$ and V_a is a domain of the attribute a , and $f:U\times A\rightarrow V$ is an information function such that $f(x,a)\in V_a$ for every $x\in U, a\in A$. The 4-tuple $S=(U,A,V,f)$ becomes an information system.

Then $ind(C)$ and $ind(D)$ are defined as two indiscernibility relations, which make up of partition of U . It is showed by symbol $U/ind(C)$. So the set number of it is denoted by $|U/ind(C)|$.

Definition 1 Suppose $S=(U,A)$ to be a decision table, $R\in A$ is an equivalence relation. R's granularity is denoted by G(R). Let $G(R)=|R|/|U^2|=|R|/|U|^2$, where it is granularity of information.

Theorem 1 Given R, $S=(U,A)$ is the information in decision table. If

$U/R=\{F_1,F_2,...,F_m\}$, then $G(R)=\sum_i^m |F_m|^2/|U|^2$.

Definition 2 Given two equivalence relations R_1 and R_2 are in *A*. If $\forall x,y\in U$, moreover $xR_1y\Rightarrow xR_2y$. It is expressed that R_1 is finer than R_2, showed by symbol "$R_1 \le R_2$".

2.2 Decision finer method based on rough set and information granularity theory

Suppose $S=(U,A)$ is an information system, and $D=\{d\}$ is the set of decision attributes. It is supposed that discrete decision attributes be t $(t\ge 2)$, ($d\in\{0, 1, \ldots, t\text{-}1\}$) . Then according to rule of $ind(d)$, the equivalence relation is denoted as $F=\{X_0,X_1,...,X_{t-1}\}$. There is, $X_i = \{x|\ \forall x\in U, d(x)=i, i=0,1,...t-1\}$. Moreover it is transferred by F . X_i is turned into X_{i1} and X_{i2} , moreover $X_{i1}\cap X_{i2}=\varnothing$, If U is a partition of S' , then $F'=\{X_0,X_1,...,X_{i-1},...,X_{t-1}\}$.

The value is also transferred. From the above, the following theorems are proposed to explain the phenomenon.

Theorem 2 Let S' be a decision table. Decision attribute comes from decomposed S . Moreover other attributes are the same as S'. For a given U , and $F=\{X_0,X_1,...,X_{t-1}\}$, it is one partition $ind(d)$ which comes from S . F' is also one partition $ind(d')$, which comes from S' , (d' is decision attribute) then $G(F')\le G(F)$.

Corollary 1 When one decision value is turned into finer in decision table, the conclusions remain true.

Corollary 2 There is a decision table S , which is turned into finer decision table S' . If $ind(d')\le ind(d)$, then $G(ind(d'))\le G(ind(d))$.

Theorem 3 Given P and Q ,they are two partition of $ind(d)$, $P=\{P_1,P_2,...,P_m\}$ $Q=\{Q_1,Q_2,...Q_m\}$. Moreover $P\ne Q$ If $\forall P_i\in P$, then $\exists Q_j\in Q$. There is $P_i\in Q_j$, then $G(P)\le G(Q)$.

Theorem 4 Suppose S' is formed by one decision decomposed into two values' decision table S. The others of S' are the same as S. If $F=\{X_0,X_1,...,X_{t-1}\}$ is a equivalence class of U according to $ind(d)$ in S, F' is a equivalence class of U in S'. (D' is decision attribute), then $d_B(F')\le d_B(F)$

Theorem 5 If the condition to be the same as Theorem 4, then $\gamma_B(F')\le\gamma_B(F)$.

Thus it can be seen that the finer the decision attribute value of a decision table is, the smaller the information granularity. The accuracy of approximation classification and the quality of approximation classification are smaller than before.

2.3 Index of evolution decision rules

We can evolution decision rules by index of Accuracy, Coverage, and Support, from the view of objective system [6].

acc(a→b)＝sup(a→b)/sup(a),
cov(a→b)= sup(a→b)/sup(b),
sup(a→b)= sup(a, b),
where

$$\sup(\alpha)=card[\{X_i\in U|\bigcap_{a\in RED}^{n} f(X_i,a_i)=\gamma_i\}]\ ,$$

$$\sup(\beta)=card[\{X_i\in U|\bigcap_{b_k\in D}^{n} f(X_i,b_i)=\tau_i\}]\ ,$$

$$\sup(\alpha,\beta)=card\ [\{X_i\in U|\bigcap_{a\in RED}^{n} f(X_i,a_i)=\gamma_i\}]\cap [\bigcap_{b_k\in D}^{n} f(X_i,b_i)=\tau_i]\}]\ .$$

3. Case Studies

The data for this study were obtained from one of the largest 3PLs in Korea of Chinese branch offices. The firm is selected because it has focused on Korean company. The main business is logistics integrated supply from China to Korean. The operation has the characteristics of representative PM.

Each Logistics Services Project location includes the land transportation, the sea transportation, which the destination is Inchon Harbor. The activities of each logistics project include warehouse, order the cabin, conveyance (local), field station, pay customs duties and check, port lading, sea transportation, and port pick up the goods. Figure 1 shows the CPM of logistics service project.

Figure. 1: CPM of Logistics Service Project.

Process of logistics service project evaluation as following:

The first step is to confirm the source data:

The essence of rough set is based upon data. So the basic sample must eliminate distortion noise. We collect type (partly) data showed Source Data Table (omitted here for S-forbids).

The second step is to confirm attributes of condition and decision:

The process focuses on TQC. For Time attribute, there are 5 time indexes of warehouse & order the cabin T1, conveyance (local) T2, port lading T3, sea transportation T4, and port pick up the goods T5. For Quality attribute, there are 5 quality indexes of right consignment ratio Q1, ratio of punctual for local conveyance Q2, ratio of satisfaction for port lading Q3, ratio of punctual for sea transportation Q4, and ratio of satisfaction port pick up the goods Q5. For Cost attribute, we set D as decision attribute. Separately, two sheets of information system will be formed according to degree of the decision subdivided. In this case, according to logistics contracts, table 1 has decision attribute of 0 and 1. Hereinto 0 represents Cost warning. 1 represents Cost safety. Furthermore table 2 has decision attribute of 0, 2, 3, and 1. Hereinto 0 represents Cost Red (serious) warning. 2 represents Cost Orange (medium) warning. 0 represents Cost Yellow (light) warning. Similarly, 1 represents Cost safety.

The third step is to deduce a discrete data from first step information system:

Because this case is concrete project, the discrete data is concluded by experts' experience in this firm. According to project's every process lasting from short to long, they define Time attribute as following T = {fast 5, a little fast 4, medium 3, a little slow 2, slow 1};

According to project's every process quality (satisfaction with service wants)

from high to low satisfaction, we define Quality attribute as following Q = {high 5, a little high 4, medium 3, a little low 2, low 1}.

U	*T*1	*T*2	*T*3	*T*4	*T*5	*Q*1	*Q*2	*Q*3	*Q*4	*Q*5	*D*
1	5	5	5	5	5	5	4	1	1	1	0
2	5	5	5	5	5	5	4	1	1	1	0
3	3	2	2	2	4	4	4	2	2	1	1
…					…						…
14	2	2	2	2	2	4	4	4	4	1	1
31	4	2	2	4	3	3	3	3	3	3	1
33	3	3	3	3	3	3	3	3	3	3	0
34	2	2	2	2	2	4	3	4	1	3	1
55	2	2	2	2	2	3	2	4	3	2	1
71	3	3	3	3	3	2	2	2	2	2	0
72	3	4	3	4	4	2	2	2	1	2	0
73	2	2	2	2	2	2	2	4	3	2	1
74	3	3	3	3	3	2	2	2	2	2	0
75	3	3	3	3	3	2	2	3	2	2	0
76	2	2	2	2	2	2	2	3	1	2	1
77	3	3	3	3	3	2	2	2	2	2	0
78	2	2	2	2	2	2	2	3	2	2	1

Table1: Information table with decision attribute value of 0, 1.

U	*T*1	*T*2	*T*3	*T*4	*T*5	*Q*1	*Q*2	*Q*3	*Q*4	*Q*5	*D*
1	5	5	5	5	5	5	4	1	1	1	0
…					…						…
3	3	2	2	2	4	4	4	2	2	1	1
8	4	4	4	4	4	4	4	2	3	2	3
9	2	2	2	2	2	4	4	4	4	1	1
13	5	5	5	5	5	4	4	1	1	1	0
14	2	2	2	2	2	4	4	4	4	1	1
15	5	5	5	5	5	4	4	1	1	1	0
16	1	1	1	1	1	5	5	5	5	5	1
17	4	4	4	4	4	5	4	3	4	4	0
18	1	1	1	1	1	5	5	5	5	5	1
29	3	2	2	2	2	4	5	4	1	5	1
30	4	4	3	4	4	3	3	3	4	3	2
33	3	3	3	3	3	3	3	3	3	3	2
34	2	2	2	2	2	4	3	4	1	3	1
35	3	3	3	3	3	3	3	3	2	3	2
36	3	3	3	3	3	3	3	3	2	3	2
53	4	4	3	4	4	3	2	3	2	2	2
70	2	2	2	2	2	3	2	4	4	2	1
78	2	2	2	2	2	2	2	3	2	2	1

Table2: Information table with decision attribute value of 0, 1, 2, 3.

The fourth step is to proceed attributes reduction.

We apply the software "Rosetta" [7] developed by Warsaw University in Poland to study the rough sets decision tables. According to the condition and decision attribution forms as fore saying, the results showed in Table 3 as following. The table of attributes reduction of decision attribute value 0, 1, 2, 3 is omitted here for S-forbids.

Reduct	Support	Length
{ *port lading T*3 }	100	1
{ *conveyance* (*local*) *T*2 , *ratio of punctual for local conveyance Q*2 ,*ratio of punctual for sea transportation Q*4 }	100	3
{ *warehouse & order the cabin T*1 , *ratio of punctual for local conveyance Q*2 ,*ratio of punctual for sea transportation Q*4 }	100	3
{ *sea transportation T*4 , *ratio of punctual for local conveyance Q*2 , *sea transportation Q*4 }	100	3
{ *warehouse & order the cabin T*1, *ratio of satisfaction for port lading Q*3 , *ratio of punctual for sea transportation Q*4 , *ratio of satisfaction port pick up the goods Q*5 }	100	4
{ *conveyance* (*local*) *T*2 , *ratio of satisfaction for port lading Q*3 , *ratio of punctual for sea transportation Q*4 , *ratio of satisfaction port pick up the goods Q*5 }	100	4
{ *sea transportation T*4 , *ratio of satisfaction for port lading Q*3 , *ratio of punctual for sea transportation Q*4 , *ratio of satisfaction port pick up the goods Q*5 }	100	4

Table 3: Attributes reduction of decision attribute value 0, 1.

In practice, the third part logistics service project managers will reference Table 4 to control the activities. According to different subdivided cost warning and concreted contract items, they focus on the key of hierarchical difference of PM.

Reduct
{ *right consignment ratio Q*1 }
{ *port lading T*3 , *ratio of satisfaction for port lading Q*3 }
{ *port lading T*3 , *ratio of satisfaction port pick up the goods Q*5 }
{ *port lading T*3 }

Table 4: Attributes reduction in consideration of hierarchical difference

The fifth step is to the cost warning decision rules inferred.

Based on the fore said Attributes reduction, we run data on the platform of ROSETTA. The decision rules can be deduced. In these rules some of them are effective, but some rules have not meaning of indication. For the sake of efficiency and precision, this paper filtrate the rules by the principia of index said 2.3. So we choose rules as:

$acc(\alpha\rightarrow\beta) \geq 0.85$, $cov(\alpha\rightarrow\beta) \geq 0.05$, $sup(\alpha\rightarrow\beta) \geq 11$. The collected rules respectively are 15 rules and 22 rules. Table 5 and another table of the rules inferred from information table are some of them. The another table of decision attributes are 0, 1, 2, 3 (omitted here for S-forbids).On the basis of experts' opinions, we choose 4 high effective rules from them, which show as Table 6.

Rule	Support	Accuracy	Coverage	Length
*port lading T*3 (1) => cost warning (1)	11	0.141026	0.392857	1
*port lading T*3 (3) => cost warning (0)	37	0.474359	0.74	1
*sea transportation T*4 (3) AND *ratio of punctual for local conveyance Q*2 (2) AND *ratio of punctual for sea transportation Q*4 (2) => cost warning (0)	13	0.166667	0.26	3
*conveyance (local) T*2 (5) AND *ratio of punctual for local conveyance Q*2 (4) AND *ratio of punctual for sea transportation Q*4 (1) => cost warning (0)	11	0.141026	0.22	3
*conveyance (local) T*2 (3) AND *ratio of punctual for local conveyance Q*2 (2) AND *ratio of punctual for sea transportation Q*4 (2) => cost warning (0)	13	0.166667	0.26	3

Table 5: the rules inferred from information table, whose decision attributes are 0, 1.

Rule	Support	Accuracy	Coverage	Length
*port lading T*3 (3) AND *ratio of punctual for sea transportation Q*4 (2) => *cost warning* (2)	31	0.397436	0.837838	2
*port lading T*3 (3) AND *ratio of satisfaction port pick up the goods Q*5 (2) => *cost warning* (2)	30	0.384615	0.810811	2
*port lading T*3 (3) AND *ratio of satisfaction for port lading Q*3 (3) => *cost warning* (2)	22	0.282051	0.594595	2
*port lading T*3 (3) AND *right consignment ratio Q*1 (3) => *cost warning* (2)	22	0.282051	0.594595	2

Table 6: the rules inferred from hierarchical difference

In Table 5 and Table 6, every row expresses one decision, with the intention of finding cost warning rule. The index which has not been in that row shows that it would not be taken into account, when we use this rule. For example, port lading *T*3 (3) AND ratio of punctual for sea transportation *Q*4 (2) => cost warning (2) indicate that: if time of port lading lasts about 18 hours, and ratio of punctual for sea transportation is in 80%-84%, then we shall deduce that this project has a higher level cost. That is to say it is in Orange warning, without considering other aspects. In practice, PM managers will adjust this two activities' time and quality to obtain total target of TQC [8]. The rest may be deduced by analogy rules.

Specially, the hierarchical difference of from Table 6 will offer finer decision support to PM process, which is the focus on by managers [9]. At the same time, the other aspects do not need more attentions on them, which are redundancy attributes. So the cost of management is being saved.

4. Rules inspection

In order to prove the rules validity, which are deduced from Table 3, to Table 6. We take out 16 samples at random from this 3PLs' project of this firm in 2005. Moreover we carry through another 6 project to do proof-test according to the principle of partnership. This result indicates that 11 samples can be judged from 12 samples, only one can not be judged. The ratio of cost warning accurate is 92%. Aim at subdivided decision parts; we also adopt this method to check up from samples. Many of them are in the Orange area from the data offered by this firm. Therefore managers will cut down the control bound to relatively narrow scope observably.

5. Conclusions

This 3PLs' project evaluation method is basis of information granularity of Rough Sets. The decision rules which are deduced by subdivided attribute simulate PM idea [10] to provide hierarchical treatment. This is target fine divided approach in project. People decompose focus factor to the level and granularity, which can be run easy. When information granularity change in a small scope, the fuzzy and uncertain questions are likely to be solved. This paper only study decision attribute subdivided. We will deal with refined condition attribute in another paper.

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