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Selection Model in Buyer-Supplier Relationships*

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Abstract: This paper proposes a new method of selecting appropriate buyer-supplier relationships (BSR) for specific projects. Because it is almost impossible in reality to establish mathematical relationships between the BSR attributes and the factors of a project, the concept of relationship indices (RI) is introduced to quantify such BSR which are in turn established through design of experiments. Based on the experimental results, the contributions of project factors, known as factors' relationship worths (RWs), are estimated. RWs are used to estimate RI and thus the type of BSR for the new case.

Key words: supply chain, buyer-supplier relationship, experimental design

Over the past years substantial research efforts have been made in the areas of the supplier selection and buyer-supplier relationships (BSR). Buyer-supplier relationships have received considerable attention in both the purchasing and the marketing literature. Olsen and Ellram reviewed, analysed and classified some key articles on buyer-supplier relationships according to their research approach[1]. Three major groups of articles were identified: The marketing literature, the purchasing literature, and articles written by members of the International Marketing and Purchasing Group. The articles have been classified as empirical, conceptual/theoretical or conceptual/theoretical and empirical; and they have also been classified as either positive/descriptive or normative prescriptive. Important contributions in the marketing and purchasing literature have been described and analysed under three headings: ① Characteristics and benefits of buyer-supplier relationships[2,3]; ② Establishment and development of buyer-supplier relationships[4,5]; ③ Managing buyer-supplier relationships[6,7].

However, the selection of most appropriate types of buyer-supplier relationships has been under research. Traditionally, make or buy decisions are first made to determine if particular components and parts in a product design are made in house or bought out from suppliers or subcontractors. For all the "buy" parts, most appropriate suppliers can be selected through various methods ranging from very systematic and comprehensive to empirical and ad hoc approaches. During this selection process, the nature or type of the relationships with the chosen suppliers is not usually included for consideration. There are two ways of considering the buyer-supplier relationship selection. One way is to incorporate such consideration into the process of supplier selection. The other way is to incorporate such consideration into the make or buy decision-making process. This paper conjoins the two approaches.

This article is built upon our insights gained from a comprehensive review of representative works in the literature. Our aim in this paper is to propose a mathematical model of the BSR selection that can be used to investigate the issues of strategic relationship. We make some specific assumptions on the index of relationship, and we adopt the method of experimental design to establish a series of BSR's characteristics and some factors for selecting BSR that cannot usually be mathematically established. A case study is conducted to illustrate the research method through a simulation model. Initial results from this simple case study already indicate that the methodology we proposed is useful for BSR selection. Findings from this research provide us with a basis to further explore wider research questions and issues of BSR selection.

1 Overview of BSR Methodology

1.1 Conceptual framework of buyer-supplier relationships

Fig.1 shows an overview of the conceptual framework proposed in this research for modelling the BSR.

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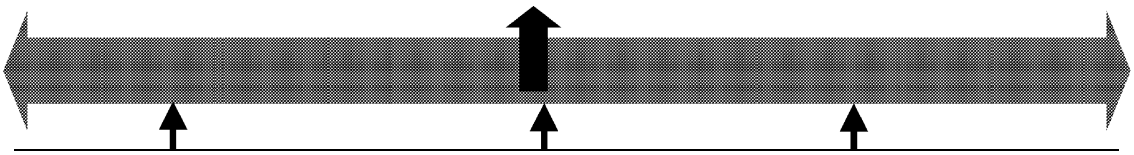
	RI	0 < RI ⩽ 20	20 < RI ⩽ 50	50 < RI ⩽ 85	85 < RI ⩽ 100
	Relationship type	Stranger	Transaction relationships	Partnerships	Vertical integrated relationships (make by self)
Characteristics	Supplier sourcing	Multiple	Multiple	Single/multiple	Single
	Activities participating	Nil	Not/partly participating	Partly participating	Wholly participating
	Resources sharing	Nil	Not sharing	Partly sharing	Wholly sharing
	Risk & award sharing	Nil	Not sharing	Partly sharing	Sharing self
	Contract length	Nil	One-off	Long-term	Long-term



Factor levels								
Core product	Non-core and customizing product	Non-core and standarding product	Not frequently	Frequently	High quality	Low cost	Timely delivery	High technique
F_{11}	F_{12}	F_{13}	F_{21}	F_{22}	F_{31}	F_{32}	F_{33}	F_{34}
Product frequency F_1			Transaction frequency F_2		Strategic vision F_3			
Factors								

Fig.1 Overview of the BSR framework

The framework adopts a number of key concepts, including 4 types of BSR, relationship indices (RI), and 5 attributes for describing each type of BSR. As we all know, the type of BSR depends on the nature of a project or case which is in turn described in terms of a set of factors and factor values. These concepts are discussed in detail in the remaining sub-sections in this section.

1.2 Types of buyer-supplier relationships and relationship index (RI)

In this paper, four types of BSR are identified:

1) "Stranger". Stranger means the relationship is "strange" in the sense that the supplier may come from an entirely new and strange environment (e.g. an emerging economy). Stranger suppliers are unlikely to cooperate with the buyer in any business activities.

2) "Transaction". Transaction relationship is a traditional relationship between buyers and suppliers. This relationship had ever been thought as the most effective mode of managing supplier relationship by enterprises in USA before partnerships in Japanese enterprises brought magnificent success[8]. In this mode, cooperation is limited and each side would emphasize their own requirements and capabilities to maximize their own business advantages.

3) "Partnerships". A partnership between a buying and a supplying enterprise has been defined as a mutual, ongoing relationship involving a commitment over an extended period, and sharing of information as well as the risks and rewards of the relationship[9]. Dyer and Ouchi defined the Japanese-style partnership (JSP) model as "an exclusive or semi-exclusive supplier-purchaser relationship that focuses on maximizing the efficiency of the entire business system"[10].

4) "Vertical". Vertically integrated relationship indicates that a buyer and its supplier should belong to the same enterprise, i.e. the "make" decision.

The concept of relationship index (RI) has been introduced in this paper between 0 and 100. RIs towards the lower extreme indicate that the relationship is "stranger" in the sense that the supplier may come from an entirely new and strange environment (e.g. an emerging economy). RIs towards the higher extreme indicate that the buyer and the supplier should belong to the same "vertically integrated" enterprise, i.e. the "make" decision. In between the two extremes are the two commonly seen types of buyer-supplier relationships. They are traditional transaction relationships and strategic partnerships. Ranges of RI have been suggested in the upper part of Fig.1 for the 4 modes or types of BSR.

1.3 Project factors determining buyer-supplier relationships

There are many factors that must be considered when selecting a mode or type of BSR for a particular project. For example, if the product or the component is extremely essential to the project, it is most likely to produce this product or component within the company or establish strategic relationship with a supplier to ensure the supply and quality of the product/compo-

nent. What factors should be included for consideration depends on the nature of the specific project. The lower part of Fig.1 shows 3 factors that are used in the subsequent case study.

1.4 BSR selection procedure

Tab.1 summarizes main steps involved in using the proposed BSR framework for predicting and selecting BSR for a specific project. There are 3 key stages in the procedure: definition stage, training stage and application stage.

Tab.1 Three stages in BSR selection

Definition stage	Training stage	Application stage
Create a model	Define product	Define product
Define factors	Define enterprise	Define enterprise
Define factor levels	Select model	Select model
	Set factor levels	Set factor levels
	Input RI	Evaluate RI
	Calculate RWs	Determine RT

Note: RI—relationship index; RW—relationship worth; RT—relationship type.

2 Model Training and Application

2.1 Calculating RWs

The purpose of training a BSR model is to establish the quantitative relationships between the RI's and the values or value levels of RF's. In this research, the design of experiments is adopted. The methodology works in a way similar to that of Conjoint Analysis[11]. The following steps are involved as indicated in Tab.2.

Tab.2 Worksheet for calculating relationship worth (RW)

Supplier	RI	F_1			F_i			F_n	
		F_{11}	F_{12}	F_{13}	F_{i1}	F_{ik}	F_{i3}	F_{n1}	F_{n2}
1	RI_1	✓				✓		✓	
j	RI_j		✓		$T_{ikj}=\begin{cases}1 & \text{if ticked}\\ 0\end{cases}$		✓	✓	
m	RI_m			✓	✓				✓
RW					$RW_{F_{ik}}=\dfrac{\sum_{j=1}^{m}(RI_jT_{ikj})}{\sum_{j=1}^{m}T_{ikj}}$				

1) Identify the factors and their value levels that are believed to have significant effects on the selection of appropriate buyer-supplier relationships.

2) Identify m specific projects to be infilled into the rows in Tab.2.

3) For each project, identify the value levels of the relevant RF's.

4) For each project, assign an RI value according to the type of BSR and its characteristics.

5) Repeat steps 3) and 4) until all projects are considered.

6) Calculate relationship worth

$$RW_{F_{ik}}=\sum_{j=1}^{m}(RI_jT_{ikj})\Big/\sum_{j=1}^{m}T_{ikj}$$

for each value level of every RF.

7) Verify RI's for all projects using the calculated RW's.

2.2 Estimating RI

RW's calculated for all RFs' value levels can be used to estimate the RI for a new project if its RFs' value levels are specified, and the RI can then be used to establish the type of the BSR. The following procedures can be followed to accomplish the above purpose:

1) Identify the factors and their value levels for the new project;

2) Estimate RI by $RI_{m+1}=\sum_{j=1}^{m+1}(RW_{F_{ik}}T_{ikj})\Big/n$;

3) Select the type of BSR according to RI_{m+1}.

2.3 An illustrative case study

To demonstrate the methodology proposed in this paper, a very simple example has been devised. The RF's and their value levels used for this example are listed in the lower part of Fig.1. The total of 19 projects are used to train the model for calculating RW's for all RFs' value levels as shown in Fig.2. The last 5 rows (except the last row) in Tab.3 are the 5 new projects whose RIs are estimated using RWs shown in Fig.2. The RI column includes all the RI values infilled for calculating RWs. In addition to the 5 new projects, we also estimated the RI values for the 19 existing

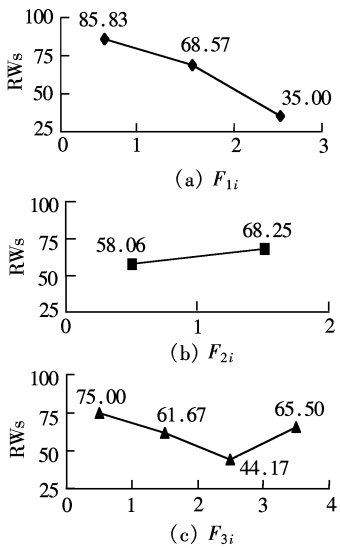


Fig.2 RWs for all RFs' value levels in the case study. (a) RWs of F_1; (b) RWs of F_2; (c) RWs of F_3

projects, as shown in the first column in Tab.3. Over half of the estimates have an error of over ± 10%. However, only one (project 18) indicates a marginal shift of the type of BSR from "Stranger" type to "Transaction" type. As the data infilled into this case study are pretty crude and limited for an illustrative purpose only, the results are expected to be improved by more data from real industrial environments.

Tab.3 Experimental test

Estimated RI			RI	F_1			F_2		F_3			
No.	RI value	Error ratio/%		F_{11}	F_{12}	F_{13}	F_{21}	F_{22}	F_{31}	F_{32}	F_{33}	F_{34}
1	92.05	- 0.5	92.5	85.83			58.06		75.00			
2	78.71	- 14.9	92.5	85.83			58.06			61.67		
4	82.55	13.9	72.5	85.83			58.06					65.50
5	102.24	10.5	92.5	85.83				68.25	75.00			
6	88.91	22.6	72.5	85.83				68.25		61.67		
8	92.74	0.3	92.5	85.83				68.25				65.50
9	74.78	3.1	72.5		68.57		58.06		75.00			
10	61.45	- 15.2	72.5		68.57		58.06			61.67		
11	43.95	- 2.3	45.0		68.57		58.06				44.17	
13	84.98	17.2	72.5		68.57			68.25	75.00			
14	71.65	- 1.2	72.5		68.57			68.25		61.67		
15	54.15	- 25.3	72.5		68.57			68.25			44.17	
16	75.48	4.1	72.5		68.57			68.25				65.50
18	27.88	85.9	15.0			35.00	58.06			61.67		
19	10.38	- 30.8	15.0			35.00	58.06				44.17	
20	31.71	- 29.5	45.0			35.00	58.06					65.50
21	51.41	14.2	45.0			35.00		68.25	75.00			
22	38.07	- 15.4	45.0			35.00		68.25		61.67		
24	41.91	- 6.9	45.0			35.00		68.25				65.50
3	61.21		85.83				58.06				44.17	
7	71.41		85.83					68.25			44.17	
12	65.28			68.57			58.06					65.50
17	41.21					35.00	58.06		75.00			
23	20.57					35.00		68.25			44.17	
	63.42		85.83	68.57		35.00	58.06	68.25	75.00	61.67	44.17	65.50

3 Concluding Discussions

A conceptual and mathematical model for selecting buyer-supplier relationship has been proposed in this paper. Conceptually, 4 types of BSR have been identified, namely, stranger, transaction relationships, partnerships, and vertical integrated relationships. Each type of BSR is characterized by 5 aspects: supplier sourcing; activities participating; resources sharing; risk & award sharing; and contract length. Which type of BSR should be established for a particular project is determined by a number of relationship factors. Mathematically, we have introduced BS relationship indices (RI) and relationship worth (RW) calculated for different value levels of each relationship factor. The RWs are then used to estimate the RI for new projects and predict the appropriate type of BSR for the new projects.

A very simple case study has been given in the paper to demonstrate how the proposed methodology works. Although the number of data infilled is limited and data themselves are rudimentary, the results are yet useful. We would expect that the results would be substantially improved once adequate number of projects are collected and infilled into the model. In addition, there are possibilities of improving the mathematical model by incorporating more sophisticated data mining techniques.

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购买方–供应商关系选择模型

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摘 要 本文提出了一个选择适当的购买方–供应商关系(BSR)的新方法.在购买方–供应商关系特征与零部件要素之间建立数学关系事实上几乎是不可能的.本文提出了关系指标(RI)的概念,并应用实验设计方法将 BSR 定量化.实验结果表明,要素的关系价值(RWs)可以估算得出,并根据 RWs 可以推算出 RI,从而为新的零部件选择适当的 BSR 类型.

关键词 供应链,购买方–供应商关系,实验设计

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