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Data envelopment analysis for imprecise data in Buyer-Seller Relationship

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Abstract

In the environment of business-to-business e-commerce, Buyers and sellers in mature industrial markets can turn single transactions into long-term beneficial relationships by a deeper understanding of the complex connection between the two and buyers and sellers are uncertain about their roles.

A “must-do” for the sellers, in particular, is to understand patterns of investment and reward, and effectively manage the process that defines the dynamics of buyer-seller evolution. This paper tries to use data envelopment analysis as a reliable and achievable tool for performance evaluating, quality and performance improvement of Buyer-Seller Relationship, in the situation where the information flows are imprecise data between buyers and sellers.

Keywords: Data Envelopment Analysis, Imprecise Data**,** Buyer-Seller Relationship.

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1. Introduction

The most important part of buyer-seller relationship is the interaction between a representative of the buying organization (buyer) and a representative of the selling organization (sales representative or sales representative). There are many other persons from both the organizations involved in the relationship, but the basic building block of the relationship is based on buyer and sales rep' interactions. The buyer and the sales representative meet, the nature of their interactions depend upon their roles, behavior and perceptions. And researchers have paid much attention to issues concerning Buyer-Seller Relationship due to demand of market. It is obvious that increase of company competition between Buyer-Sellers highlights the importance of using a proper system for evaluating its performance to recognize competition improvement opportunity. An analysis of industrial buyer behavior indicates that personal needs, interaction in the buying center, an organizational objective (or needs) determine the response of a buyer to the selling efforts by a sales rep. For example – an industrial buyer may be motivated by a personal need for salary increment and promotion in his job, and also by a social or organizational need to satisfy the user department. A buying decision may allow the buyer to satisfy both the sets of needs. Meanwhile, Buyer-Seller Relationship has been a great importance in competitive strategy to enhance organizational productivity and profitability. In this regard, different models have been introduced to evaluate Buyer-Seller Relationship performance. The model proposed by [1] named logistic score cards and [2] model are examples of all-inclusive models (overall efficiency of Buyer-Seller) and also [3] and [4] showed a number of applied researches on performance evaluation. However, study on suitable performance measurement systems are still quite limited. These days, a great variety of applications of DEA is used in evaluating the performances of many contexts in many activities such as business, trade, management and so on. Therefore, DEA is used as a powerful instrument to measure the overall chain and each subsystem (Buyer-Seller member). Also it's possible to convert imprecise data to exact data and use them to have more effective evaluation. The objectives of this paper are to provide a focused on performance assessment and improving performance of Buyer-Seller Relationship when information flow is exact and imprecise data are used as a DEA method to evaluate Buyer-Seller.

2. DEA and Buyer-Seller

Data envelopment analysis (DEA) has been widely utilized for evaluating relative efficiency of organizations with multiple input resources and output products. Recent years have seen a great variety of applications of DEA (Data Envelopment Analysis) for use in evaluating the performances of many different kinds of entities engaged in many different activities in many different contexts in many different countries. Also, strengths of DEA easily accommodate multiple inputs and multiple outputs. DEA doesn't impose a particular functional form relating inputs to outputs. DEA directly compares an observation against one or more actual peers. DEA allows inputs and outputs to be measured in very different units.

A number of DEA studies have focused on two-stage processes, so that due to the impact of intermediate measures in DMUs on the efficiency, multi stage processes have been considered in recent years, see for example [5]. After that, two stage processes was applied to the global 500 companies by [6] and [7], [8] develop a different approach for two-stage process. As a result of the fast developing technology and growing complexity of today's business, logistical systems are

becoming densely interconnected. Therefore, performance evaluation is the great importance for effective Buyer-Seller Relationship management. However, study on suitable multi-member of Buyer-Seller Relationship performance measurement systems is still quite limited, when flow of information dealing with imprecise data between multi-members of Buyer-Seller.

A Buyer-Seller Relationship is an integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers. On the other hand, a Buyer-Seller Relationship is a logistics network, which consists of all stages (e.g. order processing, purchasing, inventory control, manufacturing, and distribution) involved in producing and delivering a final product or service. At its highest level, a Buyer-Seller Relationship is comprised of two basic, integrated processes: (1) the Production Planning and Inventory Control Process, and (2) the Distribution and Logistics Process.

3. Method

Buyer-seller relationships, starting with the uncertainty situations faced by the buyer, that is, need uncertainty, market uncertainty, and transactional uncertainty. The buyer-seller relationship evolves across five stages- pre-relationship stage, exploratory stage, development stage, stable stage and final stage. This evolution depends on variables like experience, uncertainty, distance and commitment.

Depending on the extent of their interdependence, the relationships are categorized into transactional relationships, collaborative relationships, alliances and reciprocal relationships. Industrial marketers have to manage relationships with suppliers, customers and distributors. This requires analyzing supplier relationships and dimensions, acquiring the right customers, creating value, understanding the importance of power etc.

Sales representatives play a vital role in managing the relationships with customers by performing multiple functions – information exchange, negotiation and adaptation, crisis insurance, social relationship and ego-enhancement.

Uncertainty and lack of trust, power difference, deviations from agreements, institutionalized patterns of operation and distance between buyers and sellers lead to conflicts. These conflicts can be resolved through persuasion, compromise, negotiate and bargaining.

We consider a multi-member Buyer-Seller Relationship operating under DEA model when all members have imprecise information flow of each other. The proposed model also inefficient Buyer-Seller to improve their performance.

The standard data envelopment analysis (DEA) method requires that the values for all inputs and outputs should be known exactly. When some outputs and inputs are unknown decision variables such as bounded data, the DEA model becomes a non-linear programming problem and is called imprecise DEA (IDEA), [9].

Therefore, we suppose N multi stage Buyer-Sellers (BSs) peer for evaluation, as shown in Fig. 1. Namely each BS_j (j=1,2,…,N) consists of M members a series, where such as suppliers, manufacturers, wholesalers, retailers, customers and so on. Therefore, each Buyer-Seller Relationship as:

x_{pj}, (p=1,2,…,P) Inputs of first member

$z^{t}_{d_t j}$, (d_t=1,2,…,D_t),(t=1,2,…,m-1) Outputs of $(t)^{th}$ member and inputs of $(t+1)^{th}$ member

y_{qj}, (q=1,2,…,Q) Outputs of last member

In each Buyer-Seller Relationship while some of they are imprecise data.

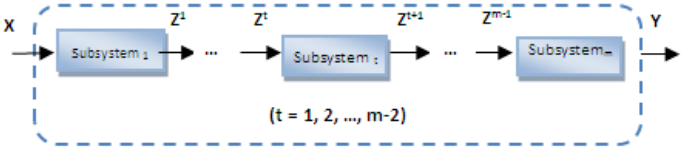

Fig 1: A multi-member Buyer-Seller Relationship

We developed models [8] with imprecise data in the way of [9].

Assume $\left[\underline{x}_{pj}, \bar{x}_{pj}\right]$ is the pth inputs of subsystem j that $\underline{x}_{pj}$ is the lower bound and $\bar{x}_{pj}$ is the upper bound of the inputs of subsystem j and $\left[\underline{z}^t_{d_t j}, \bar{z}^t_{d_t j}\right]$ is the dth intermediate measure of subsystem j (t th member) and also $\left[\underline{y}_{qj}, \bar{y}_{qj}\right]$ is the qth output of BSj. So we proposed the following multi stage model with imprecise data.

$$
\begin{aligned}
&\min \theta \\
&\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j^1 \bar{x}_{pj} + \lambda_o^1 \underline{x}_{po} \le \theta \times \underline{x}_{po}, p \in BI, \\
&\sum_{j=1}^{n} \lambda_j^1 x_{pj} \le \theta \times x_{po}, p \notin BI, \\
&\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j^t \underline{z}^t_{d_t j} + \lambda_O^t \bar{z}^t_{d_t o} \ge \bar{z}^t_{d_t o}, d_t \in BN, t = 1,...,m-1 \\
&\sum_{j=1}^{n} \lambda_j^t z^t_{d_t j} \ge z^t_{d_t o}, d_t \notin BN, t = 1,...,m-1 \\
&\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j^{t+1} \bar{z}^t_{d_t j} + \lambda_j^{t+1} \underline{z}^t_{d_t o} \le \underline{z}^t_{d_t o}, d_t \in BN, t = 1,...,m-1 \\
&\sum_{j=1}^{n} \lambda_j^{t+1} z^t_{d_t j} \le z^t_{d_t o}, d_t \notin BN, t = 1,...,m-1 \\
&\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j^m \underline{y}_{qj} + \lambda_j^m \bar{y}_{qo} \ge \bar{y}_{qo}, q \in BO, \\
&\sum_{j=1}^{n} \lambda_j^m y_{qj} \ge y_{qo}, q \notin BO, \\
&\lambda_j^t \ge 0, j = 1,2,...,n, t = 1,...,m
\end{aligned}
\qquad (1)
$$

Where BI is bounded input set, BO is bounded output set and BN is bounded intermediate measure set.

4. Application

In this section, we apply the novel developed model (1) to the data set used in table (1) which consist of 7 DMUs each having three inputs, one intermediate measure and two outputs. Two inputs of each DMU are exact and the other one is imprecise data. Moreover, the intermediate measure and the outputs are imprecise too.

5. Conclusions

Buyer-Seller Relationship performance evaluation is a complex decision-making problem involving various criteria under uncertainty situations. Our aim was to obtain a method for considering efficiency BSM with intergradations of imprecise and exact data. The presented model has important applications in real word where we don't have exact data and can't ignore at intermediate loop of BSM. It is necessary to mention that the current model can also be extended to other imprecise data (Ordinal data, ratio bounded data and Fuzzy data) and also rough parameters. More works network processes to enhance evolution of BSM is still needed. This model can be used to evaluate the performance of Buyer-Seller Relationship network. For the future studies, other uncertain DEA models such as FDEA, RDEA as well as ranking approach can be employed for performance appraisal of hospitals [8-18].

TABLE 1. DATA OF 7 BUYER-SELLER RELATIONSHIP AND PERFORMANCE EVALUATION

	X_1	$\underline{X}_2$	$\underline{X}_3$	$\bar{X}_2$	$\bar{X}_3$	Z^1_1	$\underline{Z}^1_2$	Z^2_1	$\bar{Z}^1_2$	$\underline{Z}^2_2$	$\bar{Z}^2_2$
BS1	300	50	10	80	65	70	85	150	95	43	95
BS2	122	140	80	205	108	25	12	17	12	5	20
BS3	18	20	41	80	58	65	14	25	19	5	21
BS4	67	145	11	205	402	200	1.8	24	24	3.5	65
BS5	30	7	30	60	55	13	7	21	35	18	26
BS6	190	115	103	205	217	17	7.5	60	12	10	21
BS7	440	55	22	101	33	12	11	27	17	7	18

	Z^3_1	$\underline{Z}^3_2$	$\bar{Z}^3_2$	Z^4_1	$\underline{Z}^4_2$	$\bar{Z}^4_2$	Y_1	$\underline{Y}_2$	$\bar{Y}_2$	θ
BS1	50	164	190	120	165	185	100	240	370	1.0000
BS2	12	20	26	12	7	10	25	25	36	0.3919
BS3	65	15	19	25	25	55	40	5	75	1.0000
BS4	104	40	109	305	5	15	26	6	12	1.0000
BS5	18	35	60	18	9	20	43	7	48	1.0000
BS6	28	10	17	28	3	70	8	20	55	0.9764
BS7	26	20	40	38	8	28	3	30	50	0.9385

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