

Supplier Selection Model using Game Theoretical Approach

Nagabhushan S.V¹

¹ BMS Institute of Technology , Bengaluru

Received: 7 December 2017 Accepted: 4 January 2018 Published: 15 January 2018

Abstract

The purchasing function has gained importance in supplier selection of procurement. As the evaluation of the supplier depends on various non-price attributes, formulating the strategy is very important. Every supplier tries to play tactical game in order to win the contract under uncertain situations. In our paper we propose a model through case study to select best supplier using game theoretical approach by applying simplex algorithm.

Index terms— game; payoff matrix; supplier invitation; supplier selection; game theory model.

1 Introduction

The objective of study in game theory formal model of an interactive situation between the suppliers. It typically involves several players; a game with only one player is usually called a decision problem. The formal definition lays out the players, their preferences, their information, and the strategic actions available to them, and how these influence the outcome. Game theory is the formal study of conflict and cooperation. Game theoretic concepts apply whenever the actions of several suppliers are interdependent. These suppliers may be individuals, groups, firms, or any combination of these. The concepts of game theory provide a language to formulate, structure, analyze, II.

2 Analysis

The objective is to select the best supplier from numerous suppliers with respect to understanding strategic scenarios. [1] Game theory and mechanism design offer an important tool to model, analyze, and solve decentralized design problems involving multiple autonomous agents that interact strategically in a rational and intelligent way. In the past decade, game theory and mechanism design have emerged as an important tool for solving numerous problems in computer science and Internet economics problems. Examples of these problems include design of decentralized algorithms involving selfish agents, design of sponsored search auctions on the web, design of procurement markets in electronic commerce, design of robust communication protocols, design of resource allocation mechanisms in computational grids, analysis of social networks, etc. An emerging discipline, algorithmic game theory, which is concerned with design and analysis of game theoretic algorithms, is now an active research area [3]. Basic elements of a Game:

? Players -Everyone who has an effect on your earnings ? Strategies -Actions available to each player -Define a plan of action for every contingency ? Payoffs -Numbers associated with each outcome.
-Reflect the interests of the player.

In this method, the payoff values are considered for each of the supplier with respect to the parameters and the payoff matrix is obtained from those values. The maximum and minimum values are obtained for the payoff matrix and the value of the game is obtained. Based on the value of the game, the objective function and the constraints are identified and are solved using the simplex method. The values for each supplier are calculated using the simplex model [4] and the supplier with the optimal value is considered to be the best supplier [2].

3 III.

4 Methodology a) Algorithm

The steps for the computation of an optimum solution are as follows:

Step-1: Check whether the objective function of the given L.P.P is to be maximized or minimized. If it is to be minimized then we convert it into a problem of maximizing it by using the result Minimum $Z = -\text{Maximum } (-z)$

Step-2: Check whether all right hand side values of the constraints are non-negative. If any one of values is negative then multiply the corresponding in equation of the constraints by -1, so as to get all values are nonnegative.

Step-3: Convert all the in equations of the constraints into equations by introducing slack/surplus variables in the constraints.

Step-5: Compute the net evolutions $Z_j - C_j$ ($j=1,2,...n$) by using the relation $Z_j - C_j = C_B X_j - C_j$. Examine the sign.

i) If all net evolutions are non-negative, then the initial basic feasible solution is an optimum

ii) If at least one net evolution is negative, proceed on to the next step. Put the costs of these variables equal to zero.

Step-4: Obtain an initial basic feasible solution to the problem and put it in the first column of the simplex table.

Step-6: If there is more than one negative net evolution, then choose the most negative of them. The corresponding column is called entering column. If all values in this column are ≥ 0 , then there is an unbounded solution to the given problem. If at least one value is > 0 , then the corresponding variable enters the basis.

Step-7: Compute the ratio $\{X_B / \text{Entering column}\}$ and choose the minimum of these ratios. The row which is corresponding to this minimum ratio is called leaving row. The common element which is in both entering column and leaving row is known as the leading element or key element or pivotal element of the table.

Step-8: Convert the key element to unity by dividing its row by the leading element it self and all other elements in its column to zeros by using elementary row transformations.

Step-9: Obtain the optimal value by the value in the X_B column with respect to the suppliers is basic variable column. Assumptions in the Proposed Work

5 b) Mathematical Terms

? Player(Supplier)

-It is assumed that each player knows everything about the structure of the game -Player don't know about another's decision -Each player knows the rules of the game -Players are rational and expert

6 ? Strategy

-Each player has two or more well-specified choices -Each player chooses a strategy to maximize his own payoff -Every possible combination of strategies available to the players leads to a well-defined end-state (win, loss, draw) that terminates the game

? Payoff -Everything that a player cares about is summarized in the player's payoffs

7 ? Mixed Strategy

-A player is guessing as to which activity is to be selected in any particular occasion.

-Probabilistic situation is obtained and the objective is to maximize the gain.

? Payoff Matrix -Contains the payoff values of the players with respect to the parameters.

IV.

8 Case Study

An Automobile company is intending to procure tires. There are 4 suppliers and 4 parameters as price, Quality, Delivery and Warranty. The supplier is selected based on the game theoretical method for mixed strategy game using simplex method with the following constraints. Let us consider four suppliers and four criteria's namely-Suppliers = $\{S_1, S_2, S_3, S_4\}$, Criteria's = $\{\text{Price, Quality, Delivery Time, Warranty}\}$, Let us define pay-off values as- $S_1 = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \\ 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \end{bmatrix}$ The above game has no saddle point, so solve the above matrix in LPP form

? To find the optimal value for suppliers considered as y_1, y_2, y_3, y_4 subject to constraints $3y_1 + 2y_2 + 4y_3 + y_4 = v$ $3y_1 + 4y_2 + 2y_3 + 4y_4 = v$ $4y_1 + 2y_2 + 4y_3 + 0y_4 = v$ $4y_1 + 8y_4 = v$ and $y_1 + y_2 + y_3 + y_4 = 1$ $j=1,2,3,4$ since, "v" is greater than 0 dividing the above equation by "v" and putting $y_j/v = Y_j$, $j=1,2,3,4$ $Y_1 + Y_2 + Y_3 + Y_4 = 1$ Subject to constraints $3Y_1 + 2Y_2 + 4Y_3 + Y_4 = 1$ $3Y_1 + 4Y_2 + 2Y_3 + 4Y_4 = 1$ $4Y_1 + 2Y_2 + 4Y_3 + 0Y_4 = 1$ $4Y_1 + 8Y_4 = 1$ The simplex table is written for the above SLPP as follows:- $Y_1=0, Y_2=0, Y_3=1/4, Y_4=1/8, 1/v=3/8, v=8/3$ $Y_1=y_1/v$ $y_1=Y_1.v$ $y_1=0.8/3$ $y_1=0$ similarly $y_2=0, y_3=2/3$ and $y_4=1/3$

Since y_1 and $y_2=0$, Supplier 1 and 2 are out of the game. Supplier 3 (y_3) $=2/3$ Supplier 4 (y_4) $=1/3$.

96 Since supplier 4 is having the minimal value, "S4" is considered to be the best supplier. V.1 1 1 0 0 0 0 Basic
 97 Variable C B X B Y1 Y2 Y3 Y4 S1 S2 S3 S4 Max ratio X B /Xk S1 0 1 3 2 4 0 1 0 0 0 - S2 0 1 3 4 2 4 0 1 0 0
 98 1/4 S3 0 1 4 2 4 0 0 0 1 0 - S4 0 1 0 4 0 8 0 0 0 1 1/8 1/v=0 -1 -1 -1 -1 0 0 0 0 S10

99 9 Conclusion

100 The game theoretical method allows selecting the best supplier in an effective way where the selection is done
 101 based on the strategies of the supplier used in the model. The model can be considered effective as it uses the
 102 mixed strategy game technique where the activities of another supplier are a guess and objective is always to
 maximize the gain.

I

Symbols	Description
v	Value of the game
Y _j , y _i	Represents supplier

Figure 1: Table I :

II

0], S2=[2,4,2,4], S3=[4,2,4,0] S4=[0,4,0,8]
 This can be represented as follows:

	S1	S2	S3	S4	Min
Price	3	2	4	0	0
Quality	3	4	2	4	2 min-
					max
Delivery	4	2	4	0	0
Warranty	0	4	0	8	0
max	4	4	4	8	
					maxmin

Figure 2: Table II :

2

Supplier Selection Model using Game Theoretical Approach
 Year 2018
 17
 Volume XVIII Issue III Version I
 () G
 Global Journal of Computer Science and Technology
 © 2018 Global Journals

Figure 3: Table 2 :

104 [Turocy (2001)] ‘Bernhard von Stengel ”Game Theory’. Theodore L Turocy . *Texas A&M University London*
105 *School of Economics CDAM Research Report LSE-CDAM* 2001-09 October 8, 2001.

106 [Huang et al.] *Cooperativ Game-theoretic Approach for Supplier Selection, Pricing and Inventory Decisions in a*
107 *Multilevel Supply Chain*, Yun Huang , George Q Huang , Xianan Liu .

108 [Narahari (2012)] *Game Theory*, Y Narahari . July 2012. India. Department of Computer Science and Automation
109 India Institute of Science Bangalore

110 [Hillier Gerald and Lieberman ()] *Introduction to Operation Research: Concept and Cases*, Frederick S Hillier
111 & Gerald , J Lieberman . 2006. Tata McGraw Hill. (8th Edition)