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Supplier Selection Model using Game Theoretical Approach

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Supplier Selection Model using Game Theoretical Approach

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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.

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I. 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. 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].

III. 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 = -Maximum (-z)

Step-2: Check whether all right hand side values of the constrains 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 non-negative.

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 Zj–Cj (j=1,2,…..n) by using the relation Zj – Cj = CB Xj=Cj. Examine the sign.

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

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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 $\{X_B$ / 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.

b) *Mathematical Terms*

Table I: Symbols and description

Symbols	Description
v	Value of the game
Yj, yi	Represents supplier

Assumptions in the Proposed Work

- 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
- 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
- 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. 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 = {S1, S2, S3, S4}, Criteria's = {Price, Quality, Delivery Time, Warranty}, Let us define pay-off values as-

S1=[3,3,4,0], S2=[2,4,2,4], S3=[4,2,4,0] S4=[0,4,0,8]

This can be represented as follows:

Table II: Payoff matrix for the suppliers with respect to parameters.

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

- The above game has no saddle point, so solve the above matrix in LPP form
- The maximin is 2 and minimax is 4, therefore the value for the game is 2≤4{ i, e lies between 2 and 4} Hence v>0
- To find the optimal value for suppliers considered as y1,y2,y3,y4 subject to constraints

$3y1+2y2+4y3\leq v$

$3y1+4y2+2y3+4y4\leq v$

$4y1+2y2+4y3+0y4\leq v$

$4y2+8y4\leq v$

and $y1+y2+y3+y4=1$ $j=1,2,3,4$

since, v„ is greater than 0 dividing the above equation by „v" and putting $yj/v=Yj$, $j=1,2,3,4$

$Y1+Y2+Y3+Y4=1$

Subject to constraints

$3Y1+2Y2+4Y3\leq 1$

$3Y1+4Y2+2Y3+4Y4\leq 1$

$4Y1+2Y2+4Y3+0Y4\leq 1$

4Y2+8Y4≤ 1 yj/v=Yj, j=1,2,3,4

In order to minimize v"", maximize 1/v=Y1+Y2+Y3+Y4(objective function)

The Standard LPP can be written as follows:-

Max 1/v=Y1+Y2+Y3+Y4+0.S1+0.S2+0.S3+0.S4

Subject to constraints:

3Y1+2Y2+4Y3+S1=1

3Y1+4Y2+2Y3+4Y4+S2=1Table III: Simplex Method table

4Y1+2Y2+4Y3+S3=1

4Y2+8Y4+S4=1

The simplex table is written for the above SLPP as follows:-

Y1=0, Y2=0, Y3=1/4, Y4=1/8, 1/v=3/8, v=8/3

Y1=y1/v

y1=Y1.v

y1=0.8/3

y1=0

similarly y2=0,y3=2/3 and y4=1/3

Since y1 and y2=0, Supplier 1 and 2 are out of the game. Supplier 3 (y3) =2/3 Supplier 4 (y4) =1/3.

Since supplier 4 is having the minimal value, "S4"" is considered to be the best supplier.

Table 2: Calculation Table

			1	1	1	1	0	0	0	0			
Basic 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	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			
S1	0	1	3	2	4	0	1	0	0	0	1/4	1/4	1/4
S2	0	1/2	3	2	2	0	0	1	0	-1/2	1/4	0	1/2
S3	0	1	4	2	4	0	0	0	1	0	1/4	0	0
S4	0	1/8	0	1/2	0	1	0	0	0	1/8	-	-	-
	1/v=1/8		-1	-1/2	-1	0	0	0	0	1/8			
S1	0	0	-1	0	0	0	1	-4	2	2			
S2	0	1/4	1	1	0	0	0	1	-1/2	-1/2			
S3	0	1/4	1	1/2	1	0	0	0	1/4	0			
S4	0	1/8	0	1/2	0	1	0	0	0	1/8			
	1/v=3/8		0	0	0	0	0	0	1/4	1/8			

V. Conclusion

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

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