MATCH MAKINGIN B2B USING EXTENSIVE GAMES WITH PERFECT INFORMATION

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ABSTRACT

Match making is becoming important in this rapidly changing world for identifying the required supplier and buyer pair. In this paper we are building a mathematical model using extensive games with perfect information, Nash equilibrium is found in order to find the exact match. The matching is based on multi attribute priority, the attribute are called constraints which are classified into hard and soft constraints are identified. The best matched is identified by running the algorithm on Mat Lab and even here time is considered. Two models are designed first model is one manufacturer and n-suppliers and second model is m-manufacturers and n-suppliers.

KEYWORDS

Nash Equilibrium, Extensive Game with Perfect Information, Match Making, hard constraint, soft constraint.

1.INTRODUCTION

In recent years the way of doing trade is changing from traditional face to face to e-commerce. In traditional method the trading partners who are involved in the trade will see the quality of the product, the trading partners, their band, priority for doing trade etc. In e-commerce trade which is the virtual means of doing trade in which the trading is carried on virtually no seeing the trading partner only on trust the trade is done. Some time the trade made will be profitable and some time may not be profitable. In Business-to-Business e-commerce which is a part of e-commerce in which only the exchange of goods is done between the two organizations.

Business-to-Business is the growing field of the e-commerce, where the suppliers and buyer exchange goods in the virtual e-market. Virtual B2B market identifying correct matching of the B2B e-partners is very difficult. The identifying the exact supplier and buyer is done by the matching agent who is going to identify the important attributes and match the supplier with the buyer.

The game theory concept called extensive game with perfect information is used for designing the matching agent. The extensive game with perfect information consist of a set players, a set of sequences with the property that no sequence is a proper sub history of any other sequence, a function that assigns a player to every sequence that is a proper sub history of some terminal history and for each player, preferences over the set of terminal histories. Strategies are used here where the action the player chooses for every history after which it is turn to move of theplayer. The strategy profile s* in an extensive game with perfect information is a Nash equilibrium if every player i and every strategy r(i) of player i , the terminal history O(s*) generated by s* is at least as good according to player i preferences as the terminal history O(r(i), s*(-i)) generated by the strategy profile (r(i), s*(-i)) in which player i choose r(i) while every other player j chooses s*(j). Equivalently for each player i,

Ui(O(s*))>= Ui(O(ri,s*(-i)) for every strategy ri of player i (1)

Where Ui is a payoff function that represents player i's preferences and O is the outcome function of the game.

The paper is organized as follows in section 2 literature surveys, section 3 framework model of the matching agent, section 4 result and analysis and conclusion in the section 5.

2. LITERATURE SURVEY

In this paper [1] agent are used in B2B e-commerce, where the life cycle of doing business in B2B is considered which consist of stages of negotiation of matchmaking, information of contract fulfilment. In matchmaking trading agent locates potential trading partners here a high degree of flexibility and expressiveness. Rosetta net framework of e-commerce provides only basic ontology definition for the matching stage. Math maker in b2b is designed on Fact Description Logic reasoned.

Robert J.Kauffan and Hamid Mohtadi [2] in the paper focus on the buyer role based on key variable such as point-of-scale consumer data of demand in which sharing information is done in supply chain management .E-partner profits in the presence of uncertainties about the final demand of consumer using game theoretical model. By using the demand uncertainty scenario to improve the decisions which maximize the value of their firm from the result provided to supply chain buyer. The game theoretic information schemes help in evaluating the associated profit stream on the buyer strategy.

In the paper [3] Matching software agents in B2B Markets, the software agents who are the artificial intelligent participate to enhance the efficiency and effectiveness of B2B e-commerce. The match making which is the part of the inter organizational transactions where the flow starts. In the match the supplier and buyer matching is done by considering least conflicting interest, arbitration seeks and cost. Two sided in which agents and e-business partner are matched. The matching model consists of matchmaking which consists of need identification, arrange to provide where match maker finds customer. Then come negotiations which consist of purchase and fill order. Arbitration protocol designed to allow honest partners involving in the business and avoiding dishonest and insincere partners. Here the game theoretic concept is used to match the business partner.

Steven O. Kinbrough et.al in their paper [4] artificial agent manages the electronic supply chain. Beer game is going to be best when it is played by the artificial agent rather than agents. The electronic supply chain is managed by artificial agents. Here four agents are considered the four agents represent relative wholesaler, distributer and factory. Each six bits is assigned to the each agent the artificial agent make quick decision in picking optimal rules . The Nash equilibrium to the check whether the optimal solution is met. The agent can find good policies.

In this paper [11] priority and multi objective optimization is sued for matching buyer and supplier in B2B e-market place. Multi-attribute type of matching is developed for many-to-many by using mathematical model. Genetic algorithm is used to for finding priority based multi-objective which includes multiple optimal matching solutions for decision making. For priority based multi-objective genetic algorithm to seek optimal matching solution an algorithm is designed which include multiple optimal match solution for decision maker. The optimization problem is divided into analysis, modeling, implementation and optimization. The mathematical model consists of hard constraints and soft constraints. For this priority based multi objective genetic algorithm is used. There is need for developing friendly interface for match maker and to improve the time of computing of the algorithm.

In this paper[12] a match making in P2P e-market place which uses mixes of formal datalog, fuzzy set and utility theory to match the perspective counter parts. Datalog is used for providing scalability, fuzzy logic is used for neat connection with logical constraints with logical constraints and how they would be satisfied by an agreement. Here more importance is given to soft constraints, the hard constraints which are important are not considered at all.

3. FRAMEWORK MODEL OF THE MATCHING AGENT

The framework is designed for matching virtual supplier and manufacturer present anywhere in the world given in the figure1.The list of manufacturer in form of manufacturer ID which is assigned randomly are available for ordering for the sub product is present in the module manufacture and the supplier's who are ready to manufacture the sub product and sell it to manufacturer are assigned supplier-ID randomly are available in the module supplier. The constraint module consists of list of all the constraint which are required for doing e-business. The matching process will identify the manufacturer and supplier from their ID's and then sees the constraints which are available, for matching the constraint and e-partner the Extensive Game with Perfect Information is used. . Finally the output is present in the last module best e-partners.

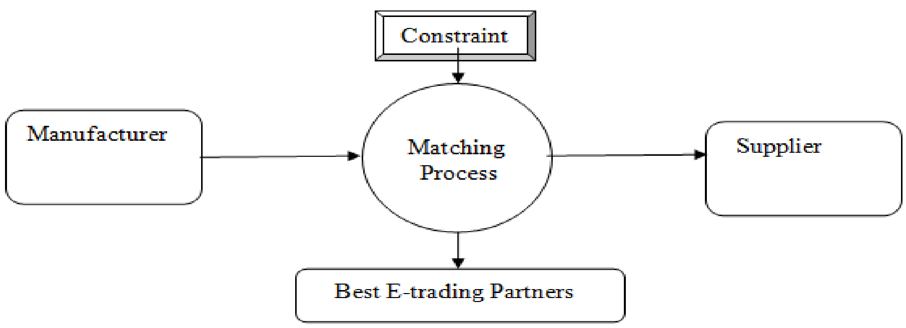

Figure 1.Framework model of matching agent.

3.1 Matching process

Matching process is an important module for finding the exact virtual partner. The figure 2 shows the process involved in the matching the manufacturer and suppliers. The matching process consists of identification of the constraint which is the important and the first step in matching. The second step is analysis in which the analysis for dividing the constraints identified in the first phase is classified into hard and soft constraints.

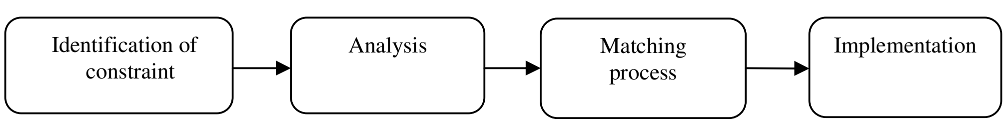

Figure 2. The matching Process

The matching process which is the third process use the game theory concept for find the match of the manufacturer and suppliers and final step is the implementation phase in which the algorithm is designed and the same is implemented in Mat lab.

3.1.1. Identification of constraint

The identification of the constraint is the very important phase of the matching process. In this phase all the important constraints are listed very carefully. The constraints identified are both related to manufacturer and suppliers. For example to manufacture Laptops all the constraints are identified by carefully observation, by careful observation the following constraints are listed the processor speed, the usage of laptop, the operating system, memory, graphics card, display size, weight, delivery time, the price.This acts as input for the next phase where the next process takes place.

3.1.2. Analysis

Analysis is the second phase of the matching process. The input which is obtained from the identification phasewhere all the important constraints are identified. In this phase the classification of the constraints are done into hard constraints and soft constraints. The hard constraints are the constraints that are exactly equal to and they cannot be less than or greater than. The soft constraints are the constraints which are greater than or lesser than the required demand and can be accepted for doing business.From the example of laptop identified constraint classify them into hard constraints and soft constraints. First the constraints operating system is considered, the manufacturer wants the laptops to be having windows7, windows8 or chrome, it means exactly the laptops should have anyone operating system so this is hard constraints. Second consider weight the laptops should be they can vary they can be less than 2kg, or in between 2kg-2.5 kg or greater than 2.5 kg , since the weight of the laptops can vary they can put under software constraint. By carefully verifying this we separate the constraint like processor speed, usage, operating system, hard drive, memory, and graphic card as hard constraints. The soft constraints are display size, weight, delivery time, price of the laptops etc. The classification of the constraints is done for finding the exact supplier and manufacturer; they should have the hard constraints and soft constraint.

3.1.3. Matching process

The matching process is the important process where the game theoretic concept is applied forthe identification of the manufacturer and suppliers for doing the business in e-market place. Theextensive games with perfect information are used for matching the virtual partners. This is shown in the form of the tree given below. The tree shows that there are two players involved in the game, the manufacturer and the supplier. The game start with active participation of the manufacturer who has two moves H and S where H means hard constraint and S is the software constraint. After manufacturer decides which way to go then supplier the second player is involved the supplier having the strategy to choose between hard constraints H and soft constraints S. The value (2,1), (3,0), (0,2) and (1,3) are called payoff are generated randomly for every iteration. The strategies been selected for example the manufacturer selects H and supplier also select H there payoff is (2,1), similarly for strategy (H,S) the payoff is (3,0), the strategy (S,H) the payoff is (0,2) and for the strategy (S,S) the payoff is (1,3).

Manufacturer

Supplier

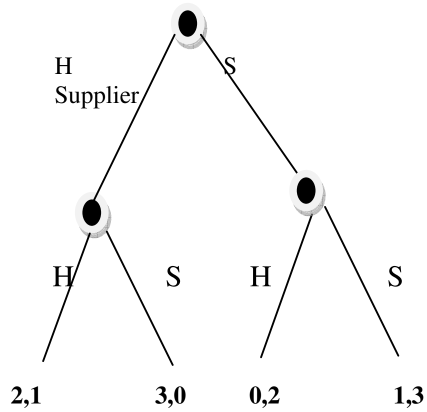

Figure 3.The extensive game with perfect information for matching agent.

The best partner for doing the B2B E-business is selected from the Nash equilibrium from the Extensive Game with Perfect Information. The Nash equilibrium is obtained only in the following situation from the equation 1.

- If manufacturer chooses the strategy H then the supplier should choose the strategy S.
- If manufacturer chooses the strategy S then the supplier should choose the strategy H.

The Nash equilibrium will not met as it will not satisfy equation 1

- If manufacturer chooses the strategy H then the supplier chooses the strategy H.
- If manufacturer chooses the strategy S then the supplier chooses the strategy S.

3.1.4. Implementation

The implementation phase is the phase in which the algorithm is written for two model. The first model consists of just one manufacturer and n-supplier and the second model consist of m-manufacturer and n-suppliers. When designing the algorithm even time required executing it found out.

The algorithm for one manufacturer and n-supplier

1. Select the supplier randomly
2. Manufacturer enters the game tree.
3. Payoff matrix is generated randomly for manufacturer and the supplier of size 2*2.
4. Let B is payoff matrix of manufacturer and C is the payoff matrix of the supplier.
5. Manufacture either select H or S strategies.
6. Supplier either select H or S.
7. Nash equilibrium is found out such that the player will not deviate from the strategies selected from them.
8. They have select strategies such manufacturer select H then supplier should select S and if the manufacturer select S then the supplier should select H.
9. T=cputime.
10. T1=randi(n). where n is the supplier selected randomly.
11. Surf(peaks(T1).
12. E=cputime-T1.

Algorithm 1.To find Nash equilibrium for one manufacturer and n-supplier.

The algorithm is used for finding the match for eligible suppliers and the manufacturer from a group of randomly selected suppliers. The payoff matrix which is of size 2*2 is generated randomly for manufacturer and the suppliers for every iteration. The value of the payoff matrix is tested for Nash equilibrium keeping in mind that manufacturer and supplier should select their strategies (H, S) where the H is the hard constraint of manufacturer and the S is the soft constraint of the suppliers or the other strategies (S, H) where S is the soft constraints selected by the manufacturer and H is the hard constraints selected by the supplier for these two strategies Nash equilibrium. These two strategies will help in matching the manufacturer and suppliers in the virtual market. The CPU time is calculated for the randomly selected suppliers. Finding the exact match using this method for one manufacturer and n-suppliers is tedious task if the algorithm is repeated the iteration for example 10 iterations finding the match we get the match in 3 iteration.

To overcome the problem of delayed matching another model m-manufacturer and n-suppliers are considered. The same algorithm is used but only the change is considering m-manufacturer randomly along with n-suppliers. When this algorithm is repeated for find the exact match out of 10 iteration in 7 iteration we can find correct match.

4. RESULT AND ANALYSIS

The algorithm for matching the exact manufacturer and suppliers is run on Mat Lab. This algorithm is run form two models one is the one manufacturer and n-suppliers model and other is the m-manufacturer and n-suppliers model. The two algorithms are run for 8 iterations each for finding the exact match of the e-business partners and also the time taken for it. The important constraints are considered during this design depending on their soft and hard constraints they are divided. The time required to get **the match for each iterations is found out.**

Iteration	Number of supplier selected randomly	Supplier Selected	Payoff Matrix	Nash Equilibrium	Strategy adopted by Manufacturer	Strategy adopted by Supplier	Time Taken in sec
1	8	6	$\begin{pmatrix} 32 & 14 \\ 44 & 12 \end{pmatrix}$	44	Hard constraints	Soft constraints	0.0156
2	2	No match					0.0313
3	9	No match					0.0156
4	7	6	$\begin{pmatrix} 11 & 11 \\ 43 & 22 \end{pmatrix}$	43	Soft constraints	Hard constraints	0.015

5	1	No match					0.0156
6	10	7	$\begin{bmatrix} 13 & 14 \\ 24 & 11 \end{bmatrix}$	24	Soft Constraints	Hard Constraints	0.034
7	11	No match					0.034
8	6	No match					0.04

Table 1. Matching using extensive game with perfect information with one manufacturer and n-suppliers in B2B

The above table 1 shows the number of iteration, number of suppliers randomly selected, randomly selected from the group, the payoff matrix, Nash equilibrium, manufacturer strategy, supplier strategy and time for getting the matching process.

The first iteration shows that 8 suppliers are available for doing the business; we want to check out these 8 suppliers which supplier will be the exact match. The next column shows that the supplier 6 is selected to do business with the manufacturer. To justify this next column consist of randomly generated payoff matrix which is of size 2*2. The payoff matrix is given below

S \ M	Hard Constraints	Soft Constraints
Hard Constraints	3 2	1 4
Soft Constraints	4 4	1 2

Table 2.Payoff Matrix to find Nash Equilibrium

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The payoff matrix show that there are two players one is the manufacturer represented by M and other is the supplier represented by S , in this game there is one manufacturer and other player is supplier6, the payoff matrix is randomly generated having the values as shown above, the value in the first column are the values of manufacturer and second column are the values of suppliers. From the equation 1 we check for Nash equilibrium in the following steps shown below:

- Consider the [3 2] payoff values here the strategy of manufacturer is hard constraints and the strategy of supplier is hard constraints, we will check whether the player change their strategy if the value of the payoff is greater than its old payoff value if it do not change the state and be in the same state its called Nash equilibrium. Changing of the manufacturer from hard constraints to soft constraints decreases the value of the payoff matrix from 3 to 1, and if supplier changes it increases the value of payoff from 2 to 4. So Hard constraints and Hard constraints cannot be Nash equilibrium.

- Consider [1 4] payoff value of manufacturer the strategy is soft constraints and supplier strategy is hard constraints here also the player deviates from the strategy as it will result in more payoff value 1 to 3 and 4 to 2 as result Soft constraints and hard constraints is not Nash equilibrium.

- Consider the strategy soft constraints and hard constraints having the payoff value [1 2] , both the players will deviate from the strategy as they get higher payoff . So this is not Nash equilibrium.

- Finally consider the strategy hard constraints and soft constraints having the payoff value [4 4] here no player will deviate from the strategy so this strategy is Nash equilibrium.

The next column shows the payoff values 44 which result in Nash equilibrium, the manufacturer strategy selected is hard constraints, the supplier strategy indicates soft constraints. The final column shows the time required for matching.

In the second iteration the number of supplier are 2, since Nash equilibrium is not met so no suppliers are selected. The entire result shows that out of 8 iterations only three iteration result in matching of the suppliers.

The chart1 shows the time computed for each iterations whether we get matching in the iteration or not. The time is obtained in seconds. The chart shows the execution of algorithm for matching of the e-partner for doing B2B e-commerce.

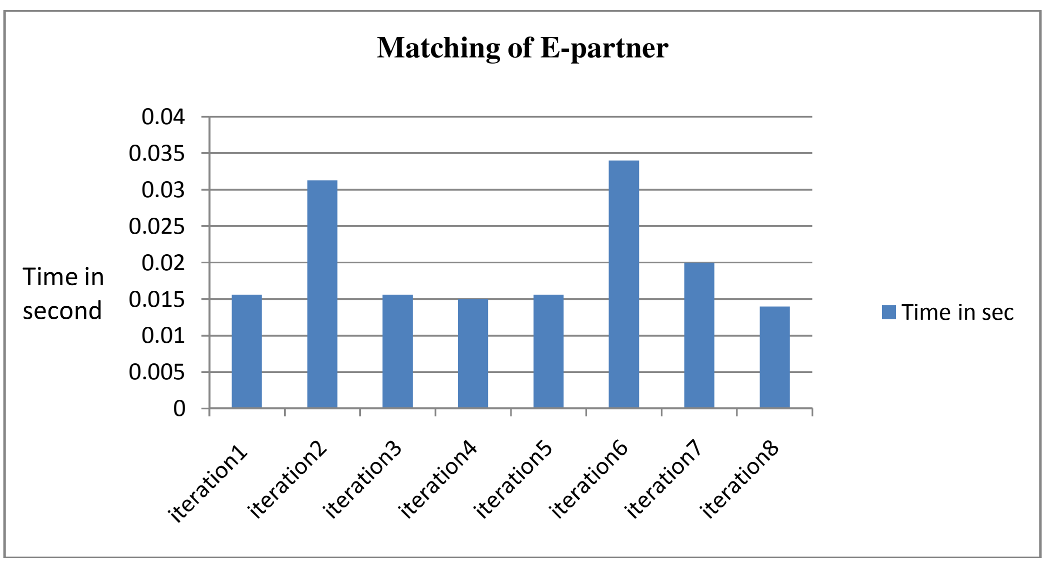

Chart 1. Matching of one manufacturer and n-suppliers in B2B e-business

The chart shows the maximum time is taken in second and sixth iteration for matching the e-business partner but in those iteration exact matched supplier are not selected. Out of these 8 iteration only three iteration resulted in matching of the e-business partners and result of the iterations no match as no supplier were selected**.**

Since the above model where there were one manufacturer and n-suppliers will result no match more, compare to the matching process in every iterations. We have decided to move m-manufacturer and n-supplier model where the manufacturer and suppliers are randomly selected. We are considering that m number of manufacturer present in the virtual e-business along with n-suppliers who are searching for exact match; this is also solved by using the extensive game with perfect information

It	N O M	N O S	S M	S S	Payoff Matrix	Nash Equilibrium	MS	SS	Time In sec
1	10	4	2	2	$\begin{pmatrix} 32 & 44 \\ 43 & 33 \end{pmatrix}$	44	Hard constraint	Soft Constraint	0.0469
			2	4	$\begin{pmatrix} 21 & 41 \\ 43 & 22 \end{pmatrix}$	43	Soft constraint	Hard constraint	0.0156
2	4	3	No match	No Match					0.0125
3	3	4	2	2	$\begin{pmatrix} 33 & 34 \\ 44 & 31 \end{pmatrix}$	44	Soft Constraint	Hard Constraint	0.0156
4	3	1	1	1	$\begin{pmatrix} 22 & 33 \\ 44 & 31 \end{pmatrix}$	44	Soft Constraint	Hard Constraint	0.0156
5	6	5	No Match	No Match					0.046
6	11	2	1	2	$\begin{pmatrix} 31 & 14 \\ 43 & 22 \end{pmatrix}$	43	Soft constraint	Hard constraint	0.0132
7	10	10	2	4	$\begin{pmatrix} 11 & 23 \\ 24 & 12 \end{pmatrix}$	24	Soft constraint	Hard Constraint	0.0313
8	10	5	5	1	$\begin{pmatrix} 32 & 44 \\ 31 & 23 \end{pmatrix}$	44	Hard Constraint	Soft Constraint	0.0215

Table 2. Matching using extensive game with perfect information with m- manufacturer and n-suppliers in B2B e-commerce

The table 2 shows the matching process for m-manufacturer and n-suppliers in the extensive game with perfect information. The first column is the iteration indicated by It, the next column is number of manufacturer indicated by NOM, next column is number of supplier indicated by NOS, next column selected manufacturer represented by SM, next column is selected suppliers represented by SS, next is the payoff matrix, next is Nash equilibrium, next column is the strategy selected by the manufacturer represented by MS, next column is the strategy selected by the supplier represented by SS and the last column is the time for getting the correct match. All the columns are same two more extra columns are added number of manufacturer and selected manufacturer.

The table 2 shows that in the iteration 1 twice manufacturer and supplier are selected in the same iteration, the manufacturer selected is same for both selection but the supplier once supplier2 is supplier4 is selected, the strategies chosen by the manufacturer is different and strategy chosen. Comparing the two models we can say number match is more in second model than the first one.

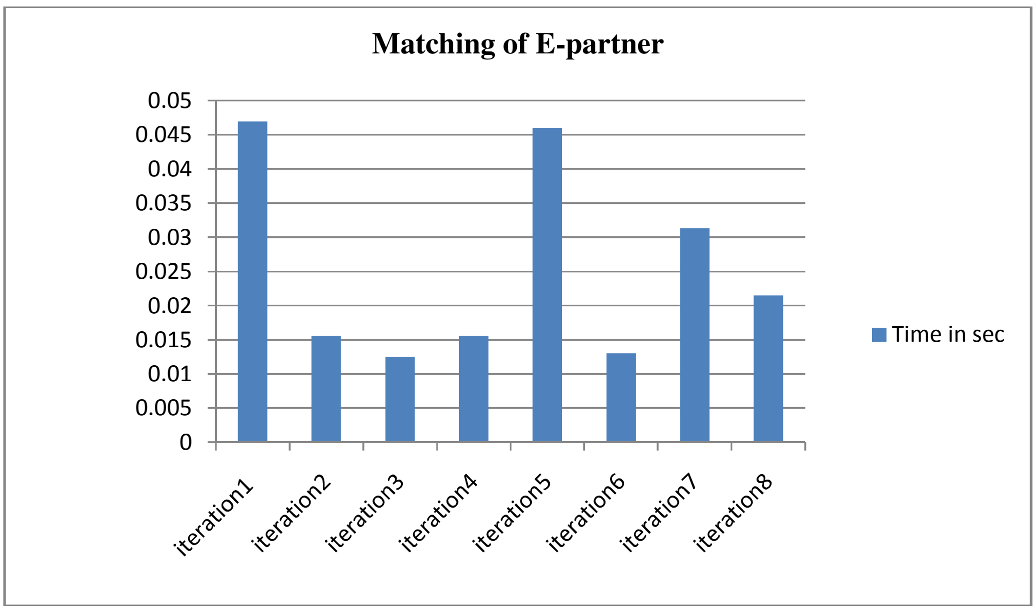

Chart 2.Matching of m- manufacturer and n-suppliers in B2B e-business.

The chart2 shows the time in second for finding the matching of the m-manufacturer and n-suppliers in 8 iteration carried on. The time in first and fifth iteration is more compared to other iterations.

Finally we compare both the model for number of matching of supplier and manufacturer for doing the e-business. We assume that if the match is there and supplier and manufacturer selected then its value is 1 and the iteration yields no match then its value is 0. By using this assumption the chart 3 is build. The chart 3 show below shows the comparisons between two models which are one manufacturer and n-suppliers and other model is the m-manufacturer and n-suppliers. Maximum number of match of supplier and the manufacturer is obtained in the second model which consists of m number of manufacturer and n number of suppliers who are going to selected randomly. The model which consists of the one manufacturer and n number of suppliers will result exact match not often the algorithm should be run number of time to get the match.

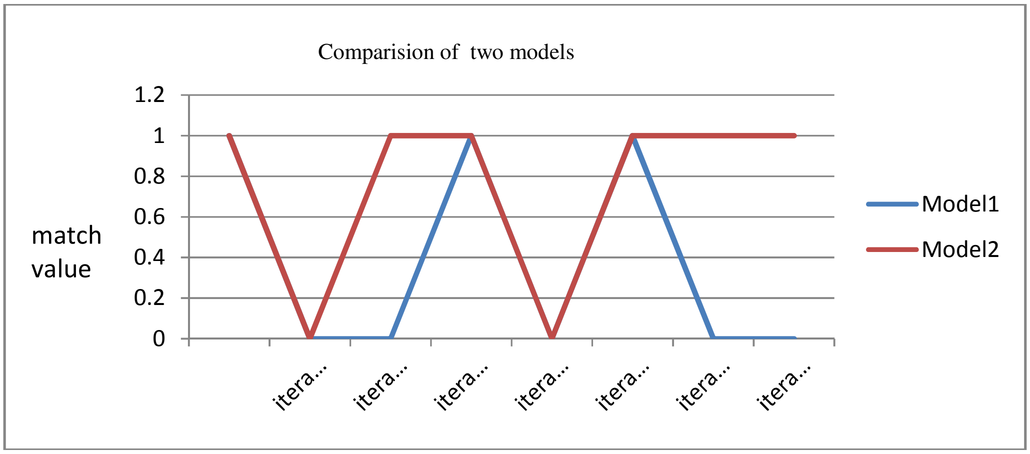

Chart 3.Comapring the two models for matching process match or not match

5.CONCLUSION

Matching is the important process of making the manufacturer and suppliers who come together for making on line virtual business. There finding are so much work done in finding the best pair of supplier and manufacturer. We have used the concept of extensive game with perfect information to find the best match using the hard constraint and soft constraint. The hard constraint should be exact it should not vary at all, where as the soft constraint can vary they can be either equal to, less than or greater than. Here we have chosen the constraint after detail surveying which can be chosen as hard constraint and soft constraint. The two models are designed the separate chart is drawn for both the models considering the time and comparison is also made for the models to find which will result in maximum match and which will not result in maximum match, the model m-manufacturer and n-supplier model yield the good number of match for the iterations.

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