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Supplier Selection Using Mobile Agents and lustering Algorithms

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Abstract: *Reducing cost, while increasing the satisfaction of the customers is so important in SCM. Because of the fast changes in the requirements and market, flexibility and agileness are two major factors in satisfying these essential issues. One way to achieve these factors is using mobile agents in the supply chain. Here, we tried to define new concept named proactive supplier selection using the feature of being event-based of mobile agents and predicting the customers' demands. We also used clustering technics and showed the improvements in the customers' response time in diagrams. We simulated both the previous model and our proposed model to show the improvement in the response time of the customers.*

Keywords: *Supplier Selection, Mobile Agent, Clustering Algorithms*

INTRODUCTION

A supply chain is a combination of enterprises, people, technologies, information and resources involved in the chain of delivering products and services, from a supplier to a customer. People involved in this chain are suppliers, vendors, logistics and retailers. These groups are working together in order to produce and distribute products in appropriate time and location, with minimum cost possible. These activities are performing with the aim of satisfying the customers' needs in order to have maximum satisfaction of the customers and optimum use of resources (Liu D., 2007).

Because of the fast changes in market and customers' requirements, the supply chain should have enough agileness and flexibility. Intelligence and automation of the activities in this chain may be effective in reducing the cycle time and increasing the performance of it. One way to increase the intelligence of these types of chains is using mobile agents in them. Mobile agents are software agents, which have the capabilities like mobility, autonomy, social ability and learning (Kaur A., et al., 2007).

There are proposed systems to increase the performance of SC using mobile agents. As can be seen in figure 1, the proposed model shows the application of the mobile agents in the supplier selection part of SCM which includes activities such as negotiation, decision making and collaboration intelligently and automatically (Wang W., et al., 2009). Selecting the supplier is the process of identifying, evaluating and contracting to the appropriate supplier. Selecting the suppliers which can provide sufficient amount of resources with desirable quality and a proper cost is so important (Davidrajuh R., 2003). After identifying the potential suppliers, a supplier that has the ability to deliver the products and services based on all the demanded factors, will be selected.

There is also a proposed framework for evaluating vendors with the aim of reducing the price and increasing the speed, flexibility and impact of procurement in the supply chain. In this framework, AHP and ISA (Intelligent Software Agent) have been used which can make intelligent decisions based on real-time information (Darade B., et al.).

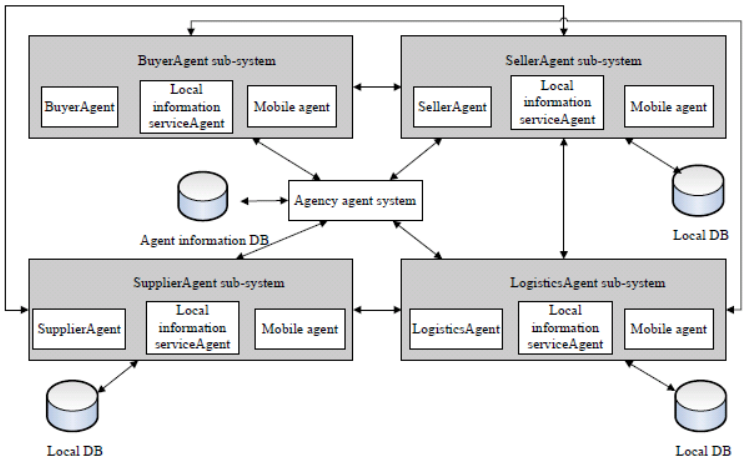


Figure 1. mobile agent system architecture

Both of the mentioned models have shortcomings such as: 1. In both models, the vendor chooses a supplier only when there is a request from the customer and there isn't an available material to respond to that request, or there is a new-coming supplier with better conditions. Doing this time-consuming task, especially after the customers' requests, will lead to the waste of time, and increase in the customers' waiting time. 2. For being aware of the arrival of new suppliers – which may offer materials with better quality and lower price in a shorter period of time- it's crucial to control the status of suppliers in market periodically. This search which may have no results will consume additional time.

One important factor in selecting a supplier is flexibility, which can be calculated using Equation 1(Liao Z., et al., 2007).

$$f_i = W_D.\left(1 - \frac{\alpha\beta_i}{p_i\mu_D} - \frac{bQ_i^{min}}{\mu_D} - \frac{c\gamma_i}{p_i\mu_D} - \frac{d\mu_D}{Q_i^{max}}\right) + W_T.\left(1 - \frac{L_i^{min}\sqrt{x_i}}{\mu_T}\right)$$

Equation 1: calculating suppliers' flexibility

Which, Q_i^{min} is the minimum and Q_i^{max} is the maximum number of orders that is acceptable by the supplier, and if the number of orders creep this scope, the customer has to pay the dedicated penalty. But as can be seen, these factors may have equal effects on the final score of the suppliers' flexibility. And the supplier with higher Q_i^{max} may have the same score as the supplier with the lower Q_i^{min}. So using this formula, understanding the differences between these two suppliers will be impossible.

To overcome the mentioned problems, we introduced a new concept, named proactive supplier selection. In the following sections, we will first introduce our proposed model, then we will describe how we use mobile agents and their benefits. And then, we will show the benefits of using clustering algorithms. And finally, based on our proposed model, we will add a new condition to the formula used for calculating the suppliers' flexibility.

Using mobile agents

Even though in some resources, mobile agents have been used to have an agile supplier selection process, since there is no proper event defined for them, the second mentioned problem still exists: In case that there

is no new coming supplier, or no change in conditions of the older suppliers, searching by mobile agents will be a time consuming and non-profit effort. To solve this problem, we used the feature of being event-based of the mobile agents. So, there is no need to peruse the status of the suppliers periodically.

We define the event which triggers the agent as: 1. registering a new supplier. 2. Changing the conditions of a previously registered supplier.

Benefits of defining these events may include these issues:

- There is no need to define a special standard for registering the suppliers. Pre requisite fields for registering can simply be consisted of the type of the material which the supplier provides. As soon as registering this supplier, all the related vendors will be informed, and all the other information may be gathered by the negotiation to the agent of that vendor if needed. Its mechanism for automation of the bidder selection has been described in (Davidrajuh R., 2003).
- Using these events would decrease the time of searching for the supplier, like the differences of polling mechanism and interruption mechanism in Operating System.

As assumed in the previous method, the vendor peruses the status and conditions of the suppliers once in a week (depending on the amount of changes in the respective industry) and this perusal needs time equal to t_1. After finding the appropriate supplier, there is a time equal to t_2 for negotiation. So, in the period of one month, the spent time for selecting a new supplier will be:

$$T= (4m/n) * (t_1+ t_2)$$

But in the proactive selection, after triggering the vendor's agent, the vendor by referring to registered suppliers and spending the time of t_1 will identify the appropriate supplier and by spending the time of t_2 will negotiate with that supplier. In this case, the amount of the time spent for selecting the supplier will be:

$$T= 1*(t_1+ t_2)$$

It is obvious that if no changes occurred in the conditions, the agents won't be triggered, and thus no time would be consumed.

Using clustering algorithms

In today's competitive condition, the vendor can predict the future demands of the customers, or the probability of the bankruptcy of a supplier, using data mining and statistic technics. But since the predictions are not definite, and the change in predicted customers' need is always possible, in this method, suppliers will be clustered using clustering algorithms such as weighted K-means (Abras G. N., et al., 2005).

Clustering refers to partitioning the set of points into a number of clusters, such that the various objective functions become optimized (Mousavian Z., et al., 2008). We can cluster the suppliers based on the sets of products they produce in a given time, frequency of orders, quality of products, delivery time of products and so on (Irfan D., et al., 2007). The benefit of the clustering suppliers is that the vendor can cluster his current and future needs as a new point with features of other suppliers, the cluster including this point will contain the most suitable suppliers, since they have more common features. This benefit becomes even bolder if the predicted needs of the customers are a little different from the actual needs.

In our model, as soon as the arrival of a new supplier or the occurrence of a change in a suppliers' condition, the suppliers will be clustered automatically, and each will be dedicated to one of the available clusters based on their effective factors. Here, even if there is an error in predictions, we still can use our clusters.

We can cluster the suppliers based on various factors, and in case that there is a probability of errors, we can have several clusters simultaneously. For instance, clustering can be done based on the parameters delivered for products from suppliers, or based on the frequency of selecting a supplier up to now. Even, we can combine parameters such as frequency with products' factors, and have multidimensional clusters. We also can have unknown (reserved) parameters, and simply update all the information if these parameters are added later.

So, the vendor not only can identify the suppliers more quickly but also, as soon as the customer demands for one of these predicted products or services, he can refer to the desirable cluster, and choose the appropriate supplier among less number of suppliers in a shorter time, which is also the best option. To choose the final supplier methods such as AHP, DEA, combination of these two (Liu J., et al., 2005) or fuzzy-AHP (Hwang H., et al., 2005) can be used.

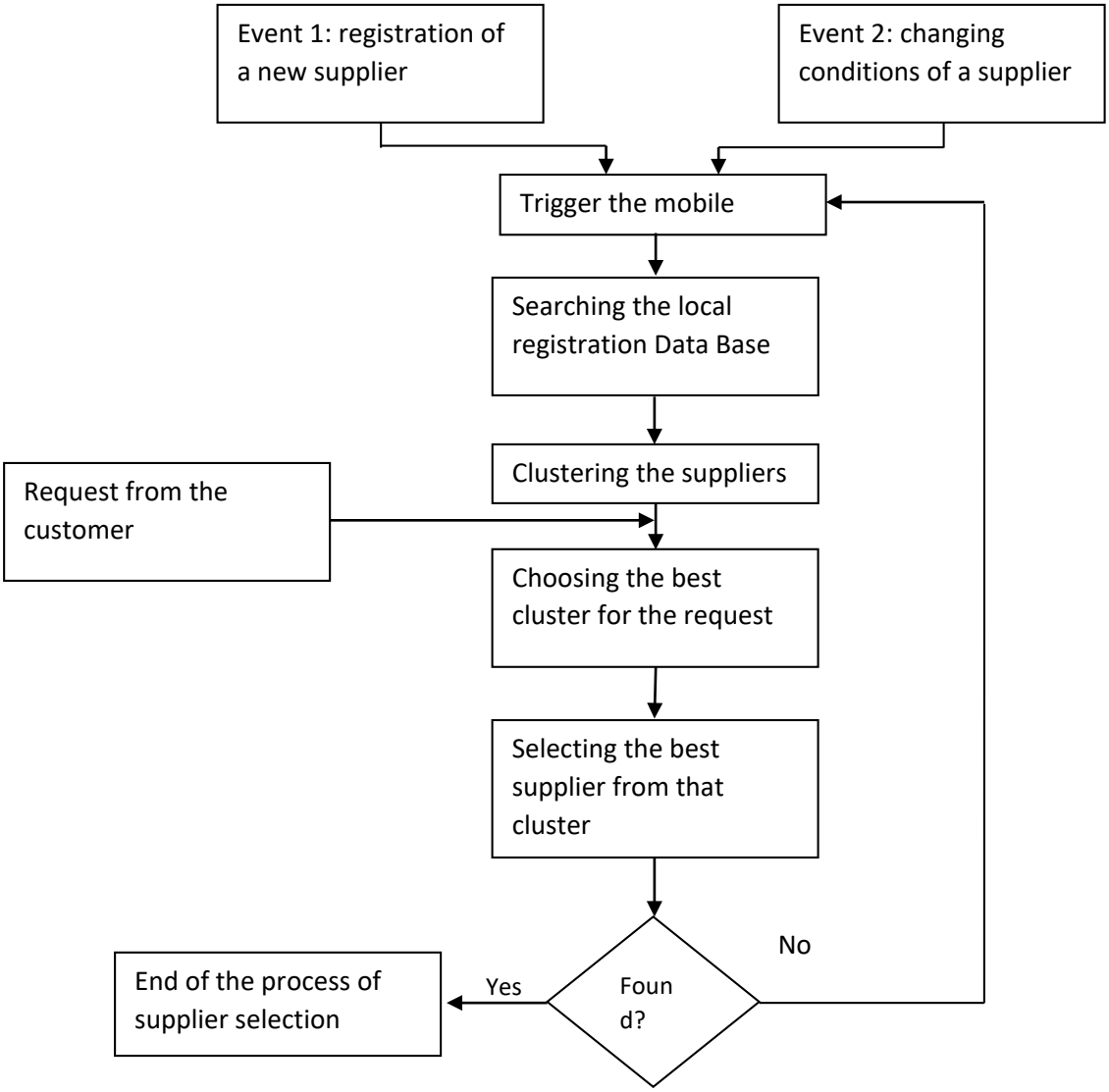


Figure 2. sequences in proactive supplier selection

Calculating the time needed for supplier selection using clustering algorithms and without using various numbers of the included data, shows the improvement in the response time. Since the searching will be done in a smaller group of data in each cluster.

Proactive supplier selection

So to resolve the first problem mentioned in the introduction, we proposed a new concept named Proactive Supplier Selection. In this model, the vendor can choose the appropriate supplier (or a group of suppliers)

according to the future needs of the customers, required resources, and the probability of bankruptcy of a supplier, before the request of the customer or the bankruptcy of a supplier.

Proactively choosing the supplier will be so useful, especially in industries in which long time maintaining of the product is impossible. In this way, the response time of the customer will decrease since the supplier for his request has been selected before. The sequences in proactive supplier selection can be seen in figure 2.

Simulation results

To understand the effectiveness of our proposed model in increasing the speed of supplier selection process, we used Arena 10 simulator. The process is designed as below:

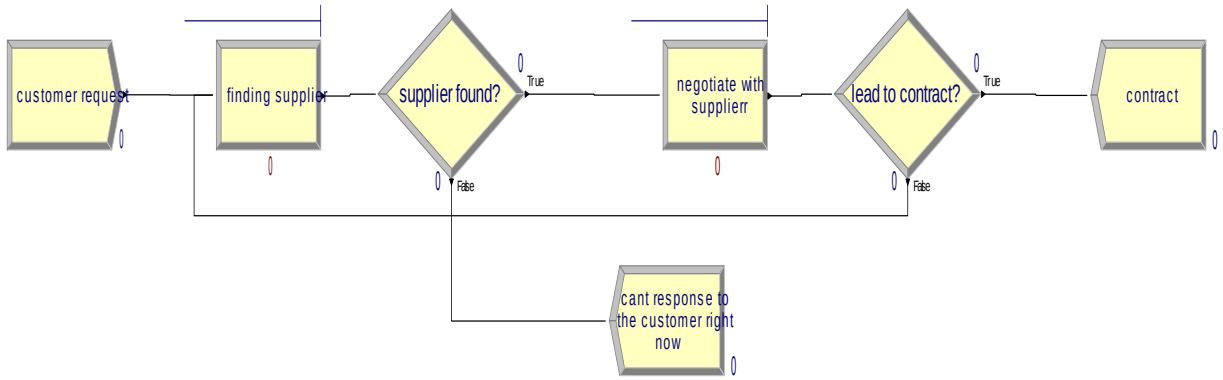


Figure 3. supplier selection process

Comparing the probabilities of finding the desirable supplier in two models shows the differences between previous model and our model. Without clustering, this probability can be calculated as:

$$\frac{\text{number of desirable suppliers}}{\text{entire state space}}$$

Which the state space factor can be calculated based on the combination of the factors of the suppliers. If we use clustering, this probability would be calculated as:

$$\frac{\text{number of desirable suppliers}}{\text{the area within the cluster}}$$

The way of calculating the area within the cluster depends on the number of factors assumed for supplier selection process. For instance, if we have two main factors, then this area would be the area within the sphere (πr^2) and if we have three factors, it would be the volume of a sphere ($\frac{4}{3}\pi r^3$).

r, or the clusters' radius is defined based on the amount of deviation acceptable for each factor. For instance, to choose a 3 ISP within K different supplier, 3 factors: speed, band width and cost have more importance. So the amount of searching needed without clustering is:

$$\frac{3}{k}$$

But using clustering this searching and finding probability would be:

$$\frac{3}{\frac{4}{3}\pi r^3}$$

In this case, r would be equal to $\sqrt{x^2 + y^2 + z^2}$. These three parameters refer to the value of three variables: speed, band width, and the cost for the ultimate point from the center of the cluster. Obviously, in each case, the area within the cluster would be equal to the overall state space. And this will occur if there is only one cluster.

For simplicity, we can assume that we have a fixed number of clusters equal to R. So the area within the cluster would be: $\frac{1}{R} \times K$, in which K is the overall state space.

For instance, the total time for supplier selection process when K=400, is:

Time

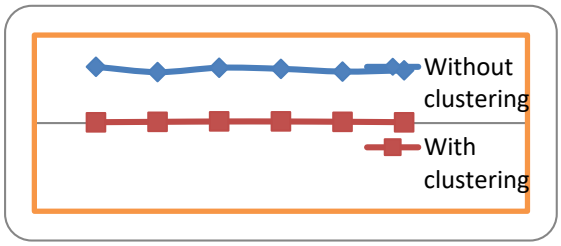
VA Time	Average	Half Width	Minimum	Maximum
order	1.0200	0.016180803	1.0000	3.0000

And this time, without clustering would be:

Time

VA Time	Average	Half Width	Minimum	Maximum
order	1.6175	0.084695811	1.0000	7.0000

With simulation of various state space, these results has been concluded:



As can be seen, in all the stated space, the time spent for the supplier selection process with clustering is much more less than the same for the case without clustering.

Calculating the flexibility

Using our proposed model, we can calculate the flexibility of suppliers more accurately with making a little change in equation 1:

$$f_i = W_D.\left(1 - \frac{\alpha\beta_i}{p_i\mu_D} - \frac{bQ_i^{min}}{\mu_D} - \frac{c\gamma_i}{p_i\mu_D} - \frac{d\mu_D}{Q_i^{max}}\right) + W_T.\left(1 - \frac{L_i^{min}\sqrt{x_i}}{\mu_T}\right)$$

As mentioned above, the vendors can predict customers' future needs, and based on this, he can predict if their order will increase in the future or decrease. If he knows that there will be a reduction in the amount of orders, it's better for him to select a customer with higher Q_i^{min}. but since the supplier with lower Q_i^{max} may have the same flexibility, it will be a probable mistake that the vendor chooses the supplier with higherQ_i^{max}. In this case, if the vendor's prediction comes true and the reduction in the customers' needs occurs, he has to pay the penalty of ordering belowQ_i^{min}.

Based on the prediction, the customers' requests will either increase or decrease. So if one of these factors: Q_i^{min} and Q_i^{max} is important for the vendor, the other one will have less importance. So we can add the

condition of :b + d = 1 to this equation to avoid selection of a supplier with lower Q_i^{min} instead of a supplier with higher Q_i^{max}.

Conclusions

In the supply chain, because of the occurrence of the fast changes in market and customers' needs, agileness and flexibility, decreasing cost and increasing customers' satisfaction are so important. One of the most important factors in the supply chain is the cycle time, that by decreasing it, the customers' satisfaction will be increased. One of the factors that can help reducing this time is using mobile agents. In this research, by using one of the features of mobile agents which is being event-based, and the ability of predicting customers' needs, we proposed a new concept named Proactive Supplier Selection which will increase the speed in the supplier selection process in comparison with the previous models. For doing so, we proposed using interrupt mechanisms and clustering technics. We showed the differences in the time needed for supplier selection between previous models and our proposed model.

We also added a condition to the equation of calculating the flexibility so that it can be calculated more tenderly. Other equations can also be checked.

Finally, it can be said that in our proposed model based on proactive approach, using event based mobile agents and clustering algorithms simultaneously, one can achieve expected speed, agileness and flexibility in the process of supplier selection in the supply chain.

References

1. Abras G. N., Ballarin L. V., 2005, A Weighted K-means Algorithm applied to Brain Tissue Classification, Journal of Computer Science & Technology-JCS&T Vol. 5 No. 3, October 2005.
2. Darade B., Dalvi S., Supplier Evaluation for Part Procurement Using ISA, Jawaharlal Nehru Engineering College, N-6, CIDCO, Aurangabad-431003, India.
3. Davidrajuh R., 2003, Modeling and implementation of supplier selection procedures for e-commerce initiatives, industrial management & Data systems, emerald.
4. Hwang H., Moon C., Chuang C, Goan M., 2005, Supplier Selection and Planning Model Using AHP, International Journal of the Information Systems for Logistics and Management (IJISLM), Vol. 1, No. 1, pp. 47-53
5. Irfan D., Xiaofei X., Shengchun D, Ali Khan I, 2007, Clustering Framework for Supply Chain Management (SCM) System, Second Workshop on Digital Media and its Application in Museum & Heritage, IEEE, computer society.
6. Kaur A., Kaur S., 2007, Role of Mobile Agents in Mobile Computing, Proceedings of National Conference on Challenges & Opportunities in Information Technology (COIT-2007), RIMT-IET, MandiGobindgarh. March 23, 2007.
7. Liao Z., Rittscher J., 2007, A multi-objective supplier selection model under stochastic demand conditions, international journal of production economics.
8. Liu J., Wu C., 2005, An Integrated Method for Supplier Selection in SCM, IEEE.
9. Liu, D. (2007). The Relationship Between Supply Chain Management and ERP in E-Business. in IFIPInternational Federation for Information Processing, Volume 254, Research and Practical Issues of Enterprise Information Systems II Volume 1, eds. L. Xu, Tjoa A., Chaudhry S. (Boston: Springer), pp. 269-273.
10. Mousavian Z., Dezfoulian M. H., 2008, New Algorithms for Online Unit Clustering, Internatioal Symposium on Telecommunications.
11. Wang W., Li T., Zhao W., Dai W., 2009, Mobile agent system for supply chain management, Proceedings of the Second Symposium International Computer Science and Computational Technology (ISCSCT '09).