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A dynamic decision approach for supplier selection using ant colony system

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ABSTRACT

Purpose: This study based on the attribute-based ant colony system (AACS) to construct a platform to examine the critical factors for decision making in a dynamic business environment in order to select the appropriate suppliers.
Design/methodology/approach: This study focuses on how to search for optimal suppliers in a similar fashion to how the optimal route can be found. The AACS is based on the ant colony system (ACS) algorithm, which is then modified to achieve the adaptive optimal system used to set the policy for companies to select their suppliers, as the researcher (as like source node) and chosen supplier's attributes to be conditions of research (destination node).
Findings: At first, we provide the development of policy model and can effective and immediately to choose the best suppliers from the company's policy and the attribute of suppliers. Secondly, this policy system is based on the platform of AACS and also modifies the new heuristics algorithm.
Research limitations/implications: There are two limitations with this study. First, the criteria for the policy and attribute numbers and sequence for suppliers must be same. Secondly, the score has evaluated by the buyer company before the decision group to use which one policy.
Practical implications: The value of this study divides two points; the parameters of AACS platform are adjustment for the buyer decision policy from dynamically business environment and the AACS can find an optimal solution from the decision policy.
Originality/value: AACS according to the decision group's policy to enter parameters in order to find the adaptive solution for buyer business firm to find their finest suppliers.

1. Introduction

Over the past decade, the need to gain global competitiveness on the supply side has increased substantially. Particularly for companies that spend a high portion of their sales revenue on raw material and component parts, savings from reduction in unit prices became much more important as their material costs take a larger percentage of total costs. Obviously selection of the right suppliers plays a key role in any organizations because it significantly reduces the unit prices and improves corporate price competitiveness. Selection of the right suppliers can improve a firm's competitive advantage, as suppliers are key participants within a supply chain channel, able to affect the quality and the price of the final goods that a business offers its customers. Consequently, the issue of supplier selection has attracted much attention within the field of 'supply chain management, and most approaches examine the problem based on several criteria, such as quality, price, service, performance and so on. However, emphasis on quality and timely delivery, in addition to the cost consideration, in today's globally competitive marketplace adds a new level of complexity to supply selection decisions. In practice, there could be several criteria used by a firm for its supplier selection decision, such as price offered, part quality, on-time delivery, after-sales services, supplier location and supplier's financial status. Apparently, supplier selection is a multi-criteria problem, which includes both quantitative and qualitative factors. For the firm to select the best suppliers, it is necessary to make trade-off between these tangible and intangible factors. Traditionally, decision group (purchasing teams) used such methods as supplier rating or supplier assessments in order to choose suppliers from the candidate supplier list. These methods assessed suppliers based on a selected number of criteria in a linear manner. Facing the new challenges in the supply chains, however, a buyer now faces multiple objectives to achieve simultaneously in its purchasing decision. Quality of parts, delivery reliability, financial status and other criteria as well as price should now be taken into account in selecting the best suppliers. In this

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paper, an approach to model development and analysis of the supplier selection problem is presented. The proposed approach, which based on AACS to implement a framework for help buyers choose the most appropriate suppliers in a dynamic environment.

The paper is organized as follow. First, we provide a review of supplier selection literature to show how the research fits with existing research. Next, we proposed an algorithm based on the criteria attributes and AACS to apply optimal supplier selection search platform, and then, computational experiences on the implementation of proposed approach along with a case study are presented. Finally, make a conclusion.

2. Relative work

Supplier selection has been discussed for more than 30 years (Micheli, Cagno, & Zorzini, 2008) and is also a popular topic within the field of supply chain management, as firms aim to choose the right suppliers in order to raise their competitive abilities (Hsu, Kannan, Leong, & Tan, 2006). Additionally, buyers choose more than one supplier to match their requirements (Ndubisi, Jantan, Hing, & Ayub, 2005; Ting & Cho, 2008), and these are chosen not only based on specific orders but also on their abilities to help the buyers achieve their future goals (Ting & Cho, 2008). In addition to this, Lo and Yeung (2006) also point out that buyers need to consider customer requirements when selecting a supplier, as this will lead to increased customer satisfaction. However, there is a gap in the current literature with regard to making such decisions based on maximizing customer satisfaction, and this study will address this issue by considering how the right supplier can be chosen on this basis in a dynamic and rapidly changing business environment?

2.1. Decision policy

Although many studies have discussed the issue of supplier selection (Bhutta & Huq, 2002; Chou & Chang, 2008; Garfamy, 2006; Kirytopoulos, Leopoulos, & Voulgaridou, 2008; Ramanathan, 2007; Sevkli, Koh, Zaim, Demirbag, & Tatoglu, 2008; Teng & Jaramillo, 2005; Ting & Cho, 2008; Wang, 2008; Yang & Chen, 2006), most of them focus on price, quality, services, delivery time, supplier location, supplier financial statues and performance.

From the late 1970s, American firms tended to focus on price and quality to increase their competitive abilities (Huang, Uppal, & Shi, 2002). Meanwhile, since the 1980s, Japanese firms have been using the principles of total quality management (TQM) to monitor their product quality (Huang et al., 2002) and to improve their supply chain operations (Ndubisi et al., 2005).

Those of settings are able to explain the decision policy of supplier selection. The reason is that buyers need to consider many conditions for supplier selection. It is estimation for buyer to verify their supplier performance. On the other hand, it is also can assist them to do a good customer service and get the advantage for the competitive market.

Gill and Ramaseshan (2007) indicated that few scholars discuss the performance during the purchasing processes or consider it as a significant factor in supplier selection. They divided this performance into five parts: (1) relationship commitment, (2) product quality, (3) price, (4) payment facilities, and (5) brand recognition. Moreover, they found that supplier commitment can strengthen the business relationship and this can then be reflected in improved product quality, price, and payment facilities, and thus increase the likelihood of repurchases.

The total cost of ownership (TCO) is a way to measure the complete purchase cost (Bhutta & Huq, 2002; Garfamy, 2006), and it can be broken down into four main parts: manufacturing costs (material, labour, and so on), quality costs (quality control, and so on), technology costs (design and engineering) and after-sales service costs. In addition to this, it is also necessary to consider other costs, such as those associated with research, transportation, and order-placement. Consequently, in this study, we divide the total cost into manufacturing, research, transportation, and order-placement costs.

Yang and Chen (2006), noted that "*Manufacturers, therefore, require suppliers to have effective systems in production management and quality control*". These effective systems are needed to manage the quality and quantity of the products manufactured, and firms now use technology and diagrams and make a process for the products management. Lo and Yeung (2006) note that supplier quality management is a essential part of TQM that can make supply channels more effective, enhance the relationships among related firms and improve their performance. It is also can expand the supplier development within supply chain management from the supplier quality (Nwankwo, Obidigbo, & Ekwulugo, 2005). With regard to supplier service, this includes the factors of delivery time, after-sales service and customer relationship service. The relationship between a buyer and supplier should be like a partnership, and the ideal supplier should be able to help their buyer to design new products from the goods that they provide.

2.2. Ant colony optimization system

Ant colony optimization (ACO) is a metaheuristic in which a colony of artificial ants cooperates in finding good solutions to difficult optimization problems. A metaheuristic is a set of algorithmic concepts that can be used to define heuristic methods applicable to a wide variety of problems. The use of metaheuristics has significantly increased the possibility of finding high quality solutions to difficult, practically relevant combinatorial optimization problems within a reasonable time, and the first ACO algorithm, called the ant colony system (ACS), was successfully applied in tacking the well-known traveling salesman problem (Dorigo & Gambardella, 1997).

The ACS is based on agents that simulate the natural behaviour of ants, develop mechanisms for cooperation, and assist them in using experience (Dorigo & Gambardella, 1997) to find the shortest path between a food source and the nest. ACS is a population-based heuristics that exploits something similar to the positive feedback that takes place when ants are able to communicate information concerning food sources via pheromones, in a process of indirect communication that is called *stimergy* in both ant and technological contexts. Ants lay a pheromone and heuristic information to mark trails. As the paths are visited by other ants, some of the trails may be reinforced and other paths may be allowed to evaporate. Pheromone trails can be observed via the number of ants passing through the trail. When there are more pheromones on a path, there is larger probability that other ants will use that path and therefore, the pheromone trail on such a path will grow faster and attract more ants to follow (so called positive feedback). An iterative local search algorithm tries to search the current paths to neighboring paths until a better solution is found.

Many researchers have worked with ACO to extend its algorithm and develop more sophisticated models. The elitist ant system (EAS) was introduced in Dorigo (1992) and Dorigo, Maniezzo, and Colorni (1991, 1996), based on the principle of providing strong additional reinforcement to the arcs belonging to the best tour found since the start of the algorithm. Note that this extra feedback can be viewed as supplementary pheromone deposited by an additional ant called the *best-so-far* ant. Arank-based ant system was proposed by Bullnheimer, Hart1, and Strauss (1999), in which each ant deposits a pheromone along with its rank. Cordon,