Design and development of agent-based procurement system to enhance business intelligence

C.K.M. Lee [a,*], H.C.W. Lau [b], G.T.S. Ho [b], William Ho [c]

[a] *Division of Systems and Engineering Management, School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore*
[b] *Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Hong Kong*
[c] *Operations and Information Management Group, Aston Business School, Aston University, Birmingham B4 7ET, United Kingdom*

Abstract

The purpose of this research is to propose a procurement system across other disciplines and retrieved information with relevant parties so as to have a better co-ordination between supply and demand sides. This paper demonstrates how to analyze the data with an agent-based procurement system (APS) to re-engineer and improve the existing procurement process. The intelligence agents take the responsibility of searching the potential suppliers, negotiation with the short-listed suppliers and evaluating the performance of suppliers based on the selection criteria with mathematical model. Manufacturing firms and trading companies spend more than half of their sales dollar in the purchase of raw material and components. Efficient data collection with high accuracy is one of the key success factors to generate quality procurement which is to purchasing right material at right quality from right suppliers. In general, the enterprises spend a significant amount of resources on data collection and storage, but too little on facilitating data analysis and sharing. To validate the feasibility of the approach, a case study on a manufacturing small and medium-sized enterprise (SME) has been conducted. APS supports the data and information analyzing technique to facilitate the decision making such that the agent can enhance the negotiation and suppler evaluation efficiency by saving time and cost.
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1. Introduction

Today's enterprises require to face the challenge of responding to turbulent market change, meeting the escalating customer requirements and providing the quality product within a short product lifecycle. Procurement is a crucial process and it accounts for more than half of enterprises' sales volume. For manufacturing firms, products are made of raw materials and components. For trading companies, purchasing the goods and then supplying the customers are the crucial business activities. As a result, procurement is regarded as a critical process in both manufacturing firms and trading companies. According to the typical example illustrated by Arnold and Chapman (2004), profit can be increased by 10% either increasing sales volume by 10% or reducing the cost of purchase by 2%. It is realized that that the efficient procurement practices can result in costly reduction, boost of profit and enhancing quality of the products. However, procurement is a complex process involving sourcing, analyzing, negotiating and assessing. A numerous problems have been identified in the past studies and shown below.

- Lack of co-ordination from buyer to production engineer.
- Lack of proactive and heavily depends on the request of production engineer.
- Paper-based purchasing cycle and lack of automation.
- Lack of intelligent advise tools provide for find out suitable suppliers.
- Difficult to evaluate the performance of the suppliers.

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* Corresponding author. Tel.: +65 6790 6891; fax: +852 23625267.
E-mail address: ckmlee@inet.polyu.edu.hk (C.K.M. Lee).

The paper is organized to meet the following objectives to resolve the above problems:

- To present a procurement system across other disciplines and retrieved information with relevant parties.
- To illustrate how data are analyzed by OLAP.
- To propose the intelligent agent to facilitate a smooth procurement cycle.
- To demonstrate the case example about applying the proposed framework in electronic industry.
- To draw some conclusions and outline the needs for further research and development.

2. Literature review

A broad range of factors that can influence the efficiency of procurement has been mentioned in the literature. Most of the companies decentralize the operational control of their business units of functions geographically, which create different cultures, mission and constraints in different parties within the supply network. These cause difficulties to perform analysis and coordination, and prompt the need for a distributed information system to accelerate the information flow within the supply chain network. Information technologies, such as ERP system and agent-based system can be one of the solutions

Agent technology can be applied in various stage of purchasing cycle. APRON system (Obonyo, Anumba, & Thorpe, 2005), which provides product specification for procurement of construction products, automates the procurement process with seller agent and buyer agent. Apart form buying and selling, tracking the status of order is important for nowadays logistics operations. Trappey, Trappey, Hou, and Chen Bird (2004) proposed a mobile agent-based online logistics service tracking system (OLTSTS) for tracking the service status with agents at the dealer and data sides where the agent passes the input information to agent center to collect the information and answer the query responsively via web portal. OLSTS includes agent center as the service tracking kernel, the supply chain coordination channel and the global logistics service operation. Hadikusumo, Petchpong, and Charoenngam (2005) suggested to use electronic purchasing agent for searching, selecting the supplier and preparing purchase order. Lau et al. also proposed to deploy virtual agent for completing the assigned tasks in the form of "methods of objects". Virtual agents are supposed to carry out the designated tasks according to the breakdown procedures for inbound logistics (Lau, Wong, Pun, & Chin, 2003). It should be noted that the various tasks undertaken by relevant agents could be carried out in geographically-dispersed companies in the supply chain network.

The assessment tools and evaluation criteria have been arisen for evaluating the performance of suppliers. Humphreys, Huang, and Cadden (2005) has proposed four types of indices to measure supplier involvement in design, namely: satisfaction index, flexibility index, risk index, and confidence index to measure the supplier capabilities and the potential or risk of signing a project contract. David-rajuh (2003) also proposed to use quality, cost, delivery and critical performance measure in binary score (i.e. 1 for the critical factor is within the broad margin while 0 for the critical factor is not within the broad margin) to select bidder.

Whilst there are many publications about applying agent technology in procurement process (Dzeng & Lin, 2004; Lau et al., 2003; Valluri & Croson, 2005), there is less literature about interconnecting the agent technology and OLAP in the whole purchasing cycle. In order to achieve responsiveness of the dynamic market, an agent-based procurement system (APS), which enables market data analysis and effective order processing, is proposed in this paper.

3. Agent-based procurement system (APS)

Agent-based procurement system consists of three major components which are data repository, business intelligence module and procurement agents including search agent, negotiation agent and evaluation agent that has been shown in Fig. 1. Instead of having a pool of suppliers, more companies tend to have partnership with their major suppliers and order higher volume with their prime vendors. Data repository stores the corporate data and the share data from suppliers and customers so as to let enterprise has better collaborative purchasing practices. Business intelligence module makes use of OLAP to navigate and manipulate the market data interactively such that the buyers can determine the purchase quantity and realize the trend of the market. During the purchasing cycle, sourcing and engaging with suppliers and settling the transaction can be carried out by software agents.

3.1. Data repository

Data repository consists of database server or mainframe system to manage structured data, accept queries from users, and respond to those queries. Data repository has the following features (Sheldom, 1997):

(i) To provide a systematic method to store data as records, tables, or objects.
(ii) To enter the data and store the data for retrieval.
(iii) To provide query languages for searching, filtering, reporting, and other data analysis activities that help users to analysis the business environment and make decision with evidence.
(iv) To provide multi-user access to data, along with security features that only allow authorized users from viewing and changing certain types of information.
(v) To maintain data integrity such that only allow one user rather than multi-users to update the record concurrently.