A Conceptual Model for Purchasing Process using Agent Based Approach in Indian Manufacturing Firms

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Abstract: *The supply chain management practices / strategies and its IT packages are adopted by the Indian Manufacturing companies to manage their supply chain. An extensive questionnaire survey was carried out among the Indian manufacturing Companies to identify the status of SCM practices and use of Information system packages to support for managing the supply chain. The study on Indian manufacturing industries (companies) confirms that the supply chain strategies and custom made information system packages are contributing very much in making companies more competitive by enhancing their capabilities at a faster rate. The custom made information system packages are contributing very much in making Indian manufacturing companies more competitive so conceptual model to demonstrate the information sharing has been developed by using multi agent technology. The paper focuses on the suitability of purchasing process using SCM strategies to improve industry processes and consequently improves the performance of manufacturing industries by means of improving operational robustness with intelligent failure recovery, reducing sourcing costs by computing the most beneficial acquisition policies in online market and improving efficiency of manufacturing processes in dynamic environments.*

Keywords: Supply chain strategies, questionnaire, custom-made packages, readymade packages, lead time, delayed orders, Multi Agent model

1. Introduction

To manage the supply chain, companies need to adopt a SCM strategy and implement appropriate SCM practices. However, different SCM strategies and practices require support from appropriate Information Technology applications and their usage.

Majority of the earlier reported works have considered only individual supply chain strategy and its effect. On the other hand the current work focused on various supply chain strategies and information system packages, their effect on manufacturing lead time, delayed orders per year, shortage of material, delayed orders to customer after due dates and % of manufacturing activities carried as per the schedule in various industries.

Purchasing is one of the basic functions of each company and it is essential for a company to work in its business environment. It is often said that the objective for purchasing is "to acquire the right quality of material, at the right time, in the right quantity, from the right source, at the right price".

Traditional manufacturing practices can no longer secure competitive advantage in the war of supply chain. Since mass production alone cannot provide the speed and today's customers require, it is time to use new manufacturing strategies in the firms to achieve the goal.

Face-to-face management, manual tracking systems, paper-dominated order processing systems, and wired communication links were the primary management tools available to purchasing managers and organization. Availability of skilled man power is seriously falling short in manufacturing industries. Communication and information sharing within the organization was difficult in above mentioned activities.

The benefits of Information technology tools and information system packages in SCM are not well practically shown by many researchers. The non SCM following industries are unaware of benefits of SCM what type of information technology tools and information system packages are following in various industries, all these factors are not known by many Indian industries.

So our main focus is on to study and analyze how these SCM strategies or IT tools and are bringing change in SCM adopted manufacturing industries.

Before the description of various agents that have been developed for performing purchasing activities automatically, a brief discussion about the information contents used for the development of agents are given below.

1.1 Steps in Purchase Process

There has been an evolution in the role and structure of the purchasing function through the nineties. The purchasing function has gained great importance in the supply chain management due to factors such as globalization, increased value added in supply, and accelerated technological change.

Purchasing involves buying the raw materials, supplies, and components for the organization. The activities associated with it include selecting and qualifying suppliers, rating supplier performance, negotiating contracts, comparing price, quality and service, sourcing goods and service, timing purchases, selling terms of sale, evaluating the value

received, predicting price, service, and sometimes demand changes, specifying the form in which goods are to be received, etc.

A key and perhaps the most important process of the purchasing function is the efficient selection of suppliers, because it brings significant savings for the organization. The objective of the supplier selection process is to reduce risk and maximize the total value for the buyer, and it involves considering a series of strategic variables.

The following are the major steps in involved in executing the purchasing function in an organization which are arranged in sequence with explanations.
1) Requisition generation & Approval
2) Identification of Suppliers
3) Evaluation of Suppliers & Bidding / Negotiating
4) Selection of Suppliers
5) Purchasing Approval
6) Purchase order release
7) Expediting and Delivery from Supplier
8) Supplier Invoice Paid
9) Update Supplier Information

2. Proposed Agents for the Automation of Purchasing Process

The Purchasing module consists of 10 agents and each AGENT is designed to perform a specific function. Each AGENT uses common database and common form for collection and display of data as shown in Fig.1.1. These agents have been described in the following sections
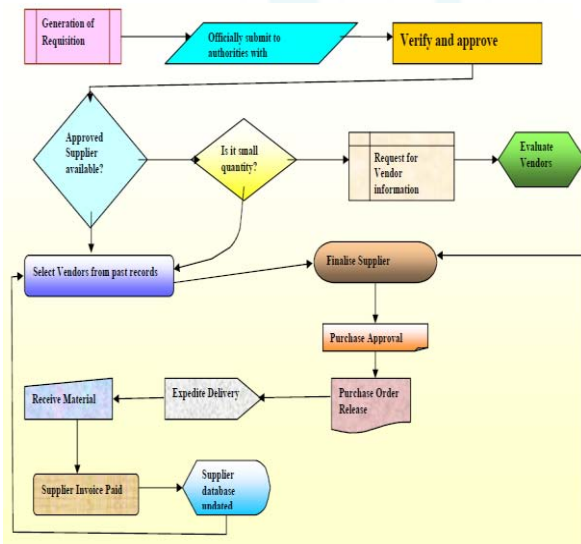

Figure 1.1: Purchasing Process

2.1 ACMRA (Availability Checking & Material Requisition Agent)

For the purpose of acquiring required material and supplies from each department an employee is authorized in each department to use the facility of logging in to view storage database for the verification of the materials available in store. This agent permit the authorized user form all departments to check availability of any materials in the store and then order the items if sufficient quantity are available in store. If sufficient quantity is not available, user

can generate and submit material requisition according to his requirements. Hence, the output from this agent is either Available Quantity (AQ) or Material Requirement form (MRF)
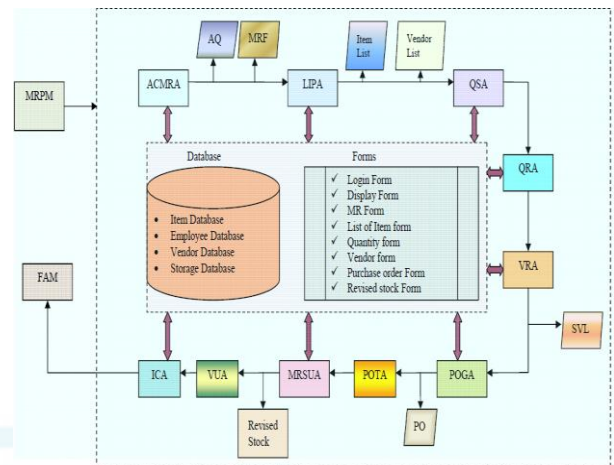

Figure 1.2: Agents identified for the generation of Purchasing Process

ACMRA-Availability Checking & Material Requisition Agent, LIPA-List of Items to Purchase Agent, QSA-Quotation Sending Agent, QRA-Quotation Receiving &listing Agent ,VRA-Vendor Rating Agent, POGA-Purchase Order Generation Agent, POTA-Purchase Order Tracking Agent, MRSUA-Material Receipt & Stock Updating Agent ,VUA-Vendor data Updating Agent, ICA-Invoice Clearance Agent, AQ-Average Quantity, MRF-Material Requisition Form, SVL-Selected Vendor List, PO-Purchase Order.

When the authorized users from any departments logs in to check availability of any materials in the store, the employee database is scanned to confirm the identity and permit the user to view available quantity.

Once, an employee successfully logs in to the application items available in the store will be displayed. The available quantity indicates the quantity existing in the store.

There may be some pending orders already requested by other users. Based on these pending orders the net quantity shows quantity that may remain in the store after satisfying the pending orders. This also becomes actual quantity available for the new user. The net quantity for the material under consideration will enable the user to take decision regarding ordering the quantity directly from the store or send material requisition form for purchasing of the items.

It means if net quantity is adequate as per his/ her requirements the authorized user can choose the option of ordering form store to obtain the required quantity. "Items in store" form will be displayed after employee successfully log in to the application.

On the other hand if sufficient quantity is not available, user can generate and submit material requisition according to his requirement by choosing the related option.

2.2 LIPA (List of Items to Purchase Agent)

This agent receives message form ACMRA and collects all Material requisitions from various departments. It then makes separate lists of all common items ordered by different departments as well as items ordered by single department. Using suitable predefined rules for common items it determines total quantity and due dates.

The quantity to be purchased will be sum of all individual requirements and accordingly the ordering quantity will be determined by pre defined purchasing polices. The due date is calculated on the basis of earliest requirement among depending up on the individual due dates.

2.3 QSA (Quotation Sending Agent)

This agent is responsible for identifying vendors for each item to be purchased from the available vendor list (From Vendor database) or acquiring information about new vendors. The available vendor list also includes the names of all those vendors which are suggested by individual departments. Every vendor listed in the existing vendor database is assigned a grade based on the performance in supply of material in all the previous orders.

Any vendor having been allotted with a poor grade is not considered for fresh order. In case of sufficient number of eligible vendors are not available in the existing vendor data base some new potential vendors are searched and invited to send their basic data highlighting the terms and conditions.

The information of all those vendors who respond positively with satisfactory terms and conditions is added to vendors' database. For effective vendor rating which leads to the identification of a good vendor an exhaustive set of data is collected from each vendor. Once the message is transferred from LIPA along with the list of items to be procured, it first identifies all the eligible vendors and then sends quotations to all eligible vendors.

2.4 QRA (Quotation Receiving and Listing Agent)

This agent accepts the responses of all the vendors to whom quotations have been sent and process the information submitted by them, in order to verify satisfaction of minimum terms and conditions and also submission of expected information which is necessary for performing vendor rating. If sufficient information is not provided than two possible actions are planned. One, to send a reminder to the vendor under consideration if, information about this vendor is available in the vendor database and has good ranking based on his performances, otherwise the second action is neglect the quotation of this vendor.

This agent compiles the available information and prepares the list of vendors who satisfy the above mentioned requirements for further processing and submit the list to VRA. It makes use standard formats which clearly specify and arrange systematically the necessary information for vendor rating.

2.5 VRA (Vendor Rating Agent)

This agent accepts the information from QRA by sending predefined message about the responses of all the eligible vendors to further process the information submitted by them. The primary objective of processing of the information is to select a suitable vendor for each item to be purchased. For this purpose, it performs vendor rating based on factors like cost, quality, delivery time and transportation cost. The final output is Selected Vendors List (SVL) (Fig.1.2)

While performing the vendor rating, first some critical factors like proximity, reputation, flexibility, stability in market, expertise and subjective factors like plant administration, cost control machining capacity etc. are considered. Vendor fulfilling the minimum requirements of critical and subjective factors are further considered for inclusion in the suggested vendors list for evaluation. No comparison is made on the basis of these factors.

Final evaluation of vendors is carried out by using weight point plan with objective factors like quality, service (delivery), and price and transportation costs. Each factor will have a certain weight depending upon its importance such that total weight is 100%.

For each vendor the scores for each factor are calculated and then vendors' performance rate is determined.

Let S_p, S_q, S_d, and S_t represent the scores of a particular vendor for performance factors price, quality, and service (delivery) and transportation costs

Similarly Let W_p, W_q, W_d, and W_t represent the weightings assigned to the performance factors price, quality, service (delivery) and transportation costs

Vendor Performance Rating for vendor under consideration is given by the sum of scores in all the performance factors i.e $VPR = S_p + S_q + S_d + S_t$

The scores can be calculated as follows:

For price of the item
$S_p = W_p \times LC / C_v$

For quality if there is r% rejects then,
$S_q = W_q (1 - r/100)$

For service, if there are 'd' late deliveries
$S_d = W_d (1 - 5 * d/100)$

For Transpiration cost, lowest price offered is taken as standard.
$S_t = W_t * \text{lowest price} / \text{actual price}$

During the process of vendor selection for a particular material say M1 the total scores which are also referred as Vendor Performance Rating, VPR is calculated for each eligible vendor.

Vendor with highest Total score / Performance Rating is selected and it will be recommended to send the purchase

order for this selected vendor. This agent presents its output as SVL (selected vendor list) and make available to other agents such as POGA.

2.6 Agent 6- POGA (Purchase Order Generation Agent)

This agent collects information from the VRA in the form of SVL about the selected vendors and generates purchase order for each of the item to be procured in a predefined form mentioning all the terms and conditions. Its output is presented as Purchase Orders (PO) (Fig.1.1). For generating purchase ordered POGA employ a standard form developed for this purpose, The form precisely indicate the Material name, quantity, delivery date and terms and conditions of purchase.

The generated purchase orders are dispatched to the respective vendors with the help of their contact details. This agent is also responsible for obtaining the confirmation that the selected vendor has received the purchase order and has sent a message of acceptance of order.

2.7 Agent 7- POTA (Purchase Order Tracking Agent)

After dispatching the purchase orders to all the selected vendors POGA transfer this information to POTA for further action. Accordingly, using the information consisting of contact details of each selected vendors POTA perform a set of well defined actions to keep track of the purchase order and maintain continuous records about the status of purchase orders. This is necessary in order to ensure that the required quantities of material are received in stipulated time. If necessary this agents also perform the function of expediting of a purchase order.

2.8 Agent 8- MRSUA (Material Receipt & Stock Updating Agent)

This agent is also called as 'stores agent' and is responsible for collecting information about the receipt of ordered quantity, confirmation about its quality and updates the quantity of respective items in store. Once, a lot is received through a purchase order in the store then the lot is checked for both quantity and quality by a team of inspectors and submits a report to MRSUA about the suitability of the received lot. MRSUA immediately updates the available quantity in the store as per the quantity received and pass this information to the agents ICA and VUA for executing their functions. In particular it sends requisite recommendations to VUA for updating the vendor data base to assign suitable grade for the current vendor.

2.9 Agent 9- VUA (Vendor Data Updating Agent)

Once a purchase order is executed successfully, MRSUA transfer the detailed information about the vendor involved in the current purchase order. If this vendor is new and supplying material first time to the organization, then the data about this vendor will be added to the vendor database with a suitable rank based on the extent to which the vendor under consideration is able to meet the terms and conditions specified in the purchase order. If the vendor involved is an existing vendor, then his rank will be updated based on his performance in executing the current purchase order.

2.10 Agent 10- ICA (Invoice Clearance Agent)

This agent act immediately after receiving message from MRSUA about the quantities of material added to store. It communicates with agents of financial aspect module and then recommends and guides to forward the invoice for payment as well confirm the payment of invoice. If the supplier has allowed certain time for the payments then this agent will obtain confirmation of such payments as and when it occurs. Once this agent executes its function the overall activities related to procurements of certain material will be completed.

With the overall performance of the above discussed multi agent model there is an improvement in the operational robustness with intelligent failure recovery, reducing sourcing costs in online market and improving efficiency of manufacturing processes in dynamic environments. Hence it may lead to the effective Information sharing between various units and improved capabilities of Supply Chain for a manufacturing organization.

3. Conclusion

In order to provide the necessary information technology support for the supply chains, the basic concepts and features of agent technology has been evaluated in order to determine its suitability for the management of supply chains. A conceptual multi agent model is proposed for the supply chain which exhibits the information sharing.

Agent-based systems provides advantages such as: improving operational robustness with intelligent failure recovery, reducing sourcing costs by computing the most beneficial acquisition policies in online market and improving efficiency of manufacturing processes in dynamic environments. The overall framework describes Agent Based Approach leading to effective Information sharing between various units and enhanced capabilities of Supply Chain for a manufacturing organization.

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