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A Data Warehouse Application Framework for Negotiation in Procurement

R. Karmakar[1*], B. B. Sarkar [2], N. Chaki [3]

[1]Department of Computer Science, The University of Burdwan, Burdwan, India
[2]Department of Computer Application, Techno International New Town, Kolkata, India
[3]Department of Computer Science & Engineering, University of Calcutta, Kolkata, India

[*]*Corresponding Author: rahulkarmakar6@gmail.com, Tel.: +91 7430912849*

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***Abstract*—** Negotiation is a long standing process during procurement. Traditional negotiation needs a complete knowledge about the business process and its legacy systems. Depending upon the size, volume and the nature of the business the criticality of the negotiation process varies. For an efficient negotiation of a large and medium size enterprise historical information's plays a vital role. A Data Warehouse along with the OLAP measures provide that support. Further the introduction of Internet the entire negotiation process is changed. The traditional transaction process is replaced by the automated transactions. The real market place is now become a virtual market place and opens new avenues for enterprises to do smart business through electronic agents. The agents are multifaceted, intelligent and autonomous and can be made enriched with the enhancement of business logics. In this paper we propose a generic framework on e-procurement process with the help of a case study in steel industry.

***Keywords*—** E-procurement, Negotiating Agents, Agent's Knowledge base, Data Warehouse, OLAP Measure

I. INTRODUCTION

An agent is a persistent autonomous software entity accomplishes tasks on behalf of a user. Agent perceives the operating context and reacts to it accordingly. Persistent emphasis continuous operation with preemption to perform some activity and autonomy implies decision making without or with minimum human intervention. Agent based applications are found effective in managing e-business over the web. In a dispersed or a distributed environment agents communicate through messages from different locations among themselves following a set of rules and protocols [6]. Research on implementation of intelligent negotiating agents is in process [1, 2, 9]. The aim of the intelligent negotiating framework is the automation of transactions between businesses (B2B) and the historical data will be available to the corresponding Data Warehouse [10].

In section 2 an ontological study on negotiation in procurement processes in real market place is presented with the fundamental knowledge bases of the virtual agent on e-procurement processes [11]. Section 3 presents summarized results on the comparative survey on traditional procurement process versus online procurement process in steel industry.

Section 4 presents the knowledge space of an agent can be thought of a collection of entities each of which we describe ontologically as units of Agent's Knowledge Base (AKB) [3]. Each unit of an AKB is a composite object consisting of attribute (static unique description of the object), behavior (set of possible actions taken by the object), data (defined data contained in the AKB) and weight (priority level of AKB).

To manage a variety of business data and turn it into effective knowledge and store them in a Data Warehouse we transform the elementary knowledge regarding raw data and abstracted information into knowledge with business intelligence [8,9]. There will be several units of particular AKB at a particular negotiating phase. A knowledge hierarchy for the operations will be built and integrate all AKBs of agent negotiations into process through appropriate link attributes and the transactions thus processed will be accumulated into a Data Warehouse for future use[8]. In section 5 we have indicated our future plan of work and section 6 presents the list of references.

The purpose of the contribution statement is for you to provide a clear and concise understanding of the primary contribution provided by your manuscript. The statement should:

1. clearly articulate the ways in which the research provides insight to a consumer-relevant question;

2. situate your research within the existing knowledge on the topic; and
3. Explain what the research adds to what is already known about the consumer-relevant problem.

In section II we give an ontological study on negotiation followed by a survey report in section III. In section IV we try to give the knowledge representation of steel procurement process and knowledge of negotiation agent is discussed in section V.

II. ONTOLOGICAL STUDY ON NEGOTIATION

Negotiation is an interaction of influences. Negotiation involves three basic elements process, behavior and substance. An intelligent agent (IA) is a software agent that assists users and acts on their behalf, in performing non-repetitive computer-related tasks. While the working of software agents used for operator assistance or data mining (sometimes referred to as bots) is often based on fixed pre programmed rules ("intelligent" in this context is often taken to imply the ability to adapt and learn**).** Agents can perform independent activities that alleviate the need for regular, routine or even peripheral tasks. It can be incorporated into recommender services for both seller and buyer. Agents can be made to analyze market trends and determine if the users are getting reliable information or the best deal for their on-line transactions. Agents can be used in negotiation, auction and reasoning. For the purpose of the case study on steel industry the process flow is presented with the help of USE CASE diagrams.

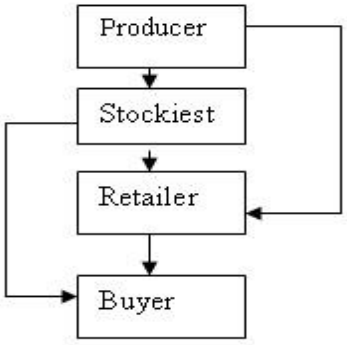

Fig.1 (a): Distribution Channel in Steel Procurement Process

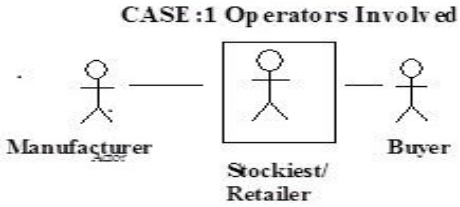

Fig-1. (b): Use Case Diagram

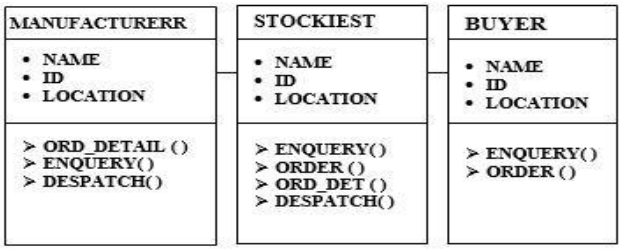

Fig-1. (c) :Class Diagram (Case-1)

III. A SURVEY REPORT ON TRADITIONAL VERSUS ONLINE STEEL PROCUREMENT PROCESSES

We have surveyed 125 odd numbers of small and medium sized steel buyers and manufacturers to assess the necessity of online procurement process. Figure2 shows the observations of the field survey data.

Parameters:

A: Reliability in terms of quality/performance	H: Payment terms
B: Level of customization/meeting with desired specifications	I: Relationship with vendors/supports
C: Timely delivery	J: Personal face-to-face contacts
D: Adequacy of product information	K: Speed of response
E: Ease of comparison	L: Reverse logistics
F: Competitive prices	M: Ease of transaction processing/ordering
G: Ease of bidding/auction	N: Confidentiality of the transaction

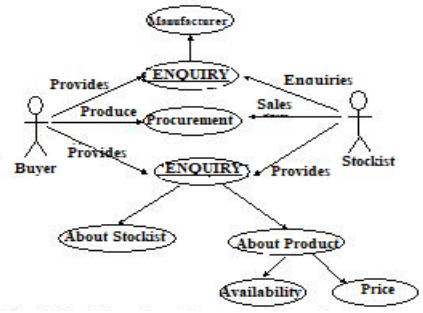

Fig.2 (a): Case-2: Buyer & Stockist

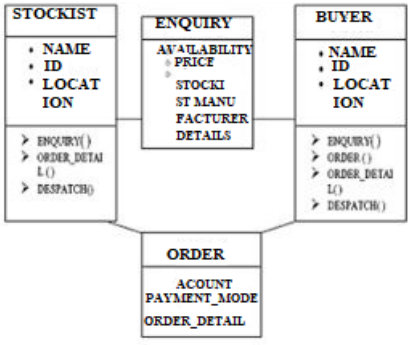

Fig. 2(b): Case-2

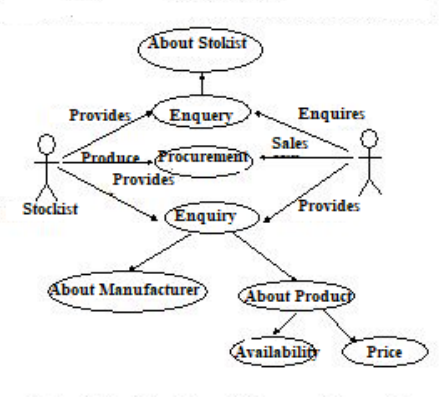

Fig. 3(a): Case -3: Stockist & Manufacturer

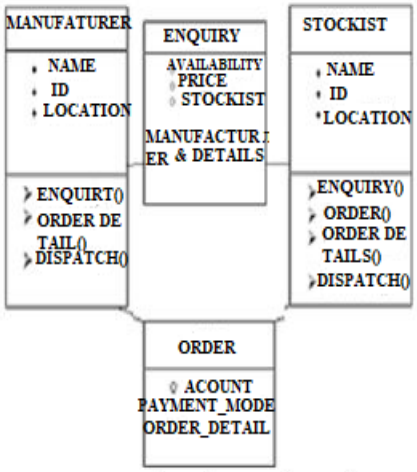

Fig. 3(b): Case -3

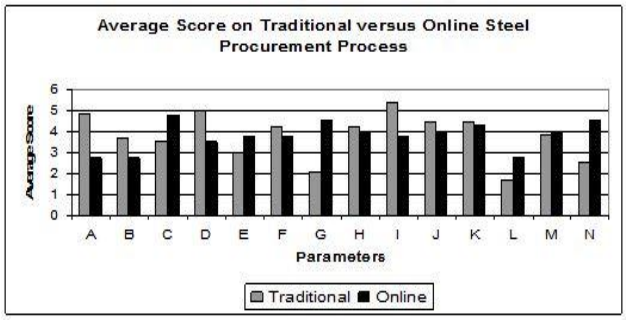

Fig 4: Average Score

IV. KNOWLEDGE REPRESENTATION IN STEEL PROCUREMENT PROCESS

In steel procurement process there are mainly three negotiating agents, namely, manufacturer, stockist and buyer (Fig.1a). We designate the corresponding AKBs as MAKB (for manufacturer), SAKB (for stockist) and BAKB (for buyer).

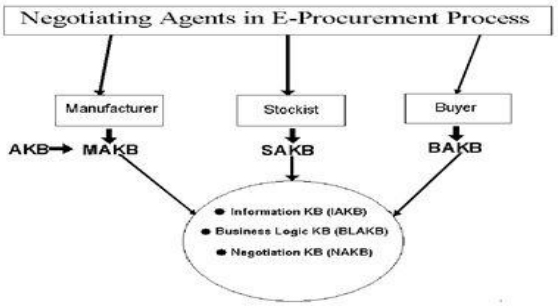

Fig 5: Negotiating Agents in E-Procurement Process

The ontology for each unit of each of these AKBs describes entities (the basis of ground level objects), classes (types of objects), attributes (properties, features or parameters that objects can share), relations (the ways the objects can be related or linked), events (the changing of attributes or relations) and weights (relative priority indicating how important is this unit).

While analyzing the survey results on real trading in steel procurement process, and developing the corresponding AKBs thereafter, we find it necessary to distinguish between negotiable attributes and non-negotiable attributes. The reason is to speed up the procurement process by negotiating only with the negotiable attributes. To do this, each agent's knowledge space is partitioned into negotiable knowledge and non-negotiable knowledge using the business intelligence involved in the e-procurement process. First one constitutes ontology-based units while the second one constitutes category-based units in the corresponding AKBs.

Business intelligence used in negotiation process is transformed into knowledge and the corresponding AKBs contain only units having negotiable attributes. The underlying knowledge in negotiation process includes buyer's/trader's preference, conditions and criteria, conventional rules for negotiation, statistics of similar deals, past trading records and so on. These are the rule-based entities in the knowledge space of the negotiable units of the corresponding AKB. In this way MAKBs, SAKBs and BAKBs are formed. The ultimate goal for developing intelligent negotiating agent for e-procurement process in steel trading is to integrate all these AKBs via links generated from the rules on these AKBs. The link attributes are developed from the underlying business transactional logics among the AKBs.

4.1. Non-negotiable Knowledge units in Steel Procurement Process

As far as steel e-procurement is concerned, the non-negotiable units of AKBs, in general, include product

templates, information about traders, requests for quotes (RFQs), quotes and contracts. Non-negotiable knowledge is category-based that contains the specification for all the entities in the e-procurement process. These are implemented through templates. For example, the templates for product space are organized on the basis of product categories. The product space is represented as a labelled directed graph with two types of nodes; namely, a leaf node and a category node (see Fig.2). A category node represents the non-negotiable knowledge unit. A leaf node represents the knowledge unit that inherits attributes and behaviours from its parent category node added with new features and operations

.4.2 Negotiable-knowledge units in Steel Procurement Process

The negotiable-knowledge unit of AKB describes the property of the currently specified AKB and the linkage between this AKB and other AKBs by some link attributes or pivots. Let us take an example from the buyer's point of view. In B2B, a buyer is a lower level manufacturer. Let us consider the case of procurement of different kinds steel sheets by a steel furniture manufacturer (Fig. 4, a buyer in steel B2B system). The buyer may have some preference applicable to all the requested products. Then for the buyer's agent, a unit called RFQ of BAKB is constructed and another unit of BAKB called CP of common preferences is defined. Each RFQ unit can then refer to this common unit CP of the buyer's preference.

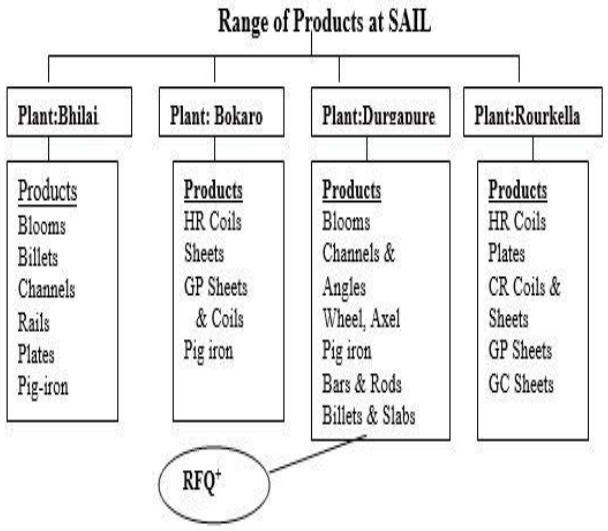

Fig 6: Steel Products

If the buyer decides to change or compromise on the preferred attributes during further negotiation, the change only in the CP of BAKB will then be automatically forwarded to all the applicable units of the BAKBs. In this case, all attributes in the common knowledge unit of BAKB become link attributes.

Link attributes provide an efficient way to allow traders dynamically change their preferences and evaluation criteria in the whole procurement process, especially during negotiation. A link is an if-then rule defined on some link attributes. With a concept-based alternatives defined in the current unit of a particular AKB can lead to one or more different units of the same or different AKBs with adjusted attributes and weights.

4.3. Knowledge Integration

Once the negotiable and non-negotiable units of three AKBs are formed, the next task is to integrate them by producing links generated from the rules on these AKBs. The rules on AKBs are based on business conventions and negotiation strategies. A natural way to represent this knowledge unit is to use if-then rules. The '*if* statement is to state the condition(s) that must be satisfied for the '*then*' statement to be executed. The rules by themselves are not represented in the units of AKBs, instead, they serve to reveal the possible links among the units of AKBs. An example is: *If* the Delivery Date in a quote offered by a stockist (seller) is less than 5 days, *then* the buyer can further ask for a reduced price of 30% for the requested product. Here Delivery Date is a negotiable attribute which will trigger a new RFQ if the condition in this rule is satisfied.

V. KNOWLEDGE OF NEGOTIATING AGENT IN STEEL-PROCUREMENT PROCESS

As mentioned earlier, there are mainly three broad classes of agents in steel procurement process, whose knowledge spaces are transformed into MAKB, SAKB and BAKB. The knowledge space of each of these agents can be divided into three knowledge bases, namely, *information knowledge base*, *business logics knowledge base* and *negotiation knowledge base*. These are accordingly transformed hierarchically as different AKBs namely, IAKB, BLAKB and NAKB respectively. IAKB are responsible for formulating the elementary knowledge in category-based units of related AKBs. BLAKB are equipped with knowledge management capabilities and serves NAKB as a back-end assistant in providing the business intelligence which is needed in negotiating scenario. Equipped with specified knowledge and formulated intelligence in a particular context of negotiation, an NAKB completes the negotiation process through the following steps:

1. Collect a preliminary set of quotes from suppliers' information agents;
2. Perform assessment on collected quotes and screen for a negotiable set of quotes;
3. For each quote candidate, negotiate with the supplier's negotiating agent using the negotiable attributes, buyer's concern, additional constraints, together with the business intelligence in various forms;

4. Done, if a contract can be reached and record the deal accordingly; aborts if failed.

Note that in steps 3 and 4, both the information and knowledge agents are invoked, providing as well as updating the non-negotiable knowledge and the meta-knowledge needed by the negotiating agent. We give below a brief description of purchase procedure and negotiation in steel procurement process which are the basis for the development of the structures of several units of different AKBs for the agents involved.

Purchase Procedure: Requisitioning (Phase where corporate purchasing agents decide what products and services are required), Request for Quotation (RFQ) (Phase where agents solicit and search for products/services from external companies/vendors), Vendor Selection (Phase where agents determine which company(s)/vendor(s) is (are) the most appropriate and compatible for the required products/services), Purchase Order (Phase where agents create purchase orders for the products/services and deliver them to the selected vendors.), Delivery (Phase where agents determine whether the products/services ordered equates quantitatively and qualitatively to the products/services delivered.), Payment Processing (Phase where agents are engaged in making the initiating company to compensate other collaborating companies.).

Negotiation Procedure: (1) Opening of Tenders (Phase where agents open and verify the quotations according to business laws provided by the Govt. and the initiating company.), (2) Comparative Statement (Phase where agents prepare comparative statements on the basis of rates, quantities, qualities, delivery periods, past market credentials, credit-worthiness etc.), (3) Hard Negotiation (Phase where agents are engaged in detailed and in depth negotiations in each and every component of (2). In general, three quotations are picked up at this step.), (4) Conversion (Phase where agents convert all negotiations into tangible form i.e., in terms of money value. This generates three forms: L1 (lowest), L2 (next to L1) and L3 (next to L2).) and (5) Selection (Phase where agents go for L1 on the output of (4).)

5.1 Examples of AKB involved in Purchasing Billets

Non-negotiable unit of SAKB: Name and other information (general attributes) of the company/ stockist dealt with the product (Billets of SAIL, in our example).

Table-1: Knowledge Base Templates for Purchasing Billets (SAKB)

Attributes	Value	Weight	Optimized Weight	Negotiable
Size	**125 mm x 125 mm IS 2830**	**10**	**570**	**N**
Sectional Weight	**122.6 Kg/meter**	**10**	**570**	**N**
Length	**9 to 10.8 meters**	**10**	**570**	**N**
Features	**Carbon(0.31 – 0.45) %**	**4**	**1425**	**Y**
	Forging Quality as per IS-1875 And Micro alloyed billets (with niobium / vanadium / titanium additions	**5**	**1140**	**Y**
Packing	**Bare, loose or stapled bundles of 4 to 5 metric tons (four pieces)**	**8**	**713**	**Y**
Invoicing	**On actual weight basis**	**10**	**570**	**N**
PRIVATE ATTRIBUTE				
Quantity_ Ordered	**>100 metric Ton**	**NA**	**NA**	**Rule: QTO1**
Delivery_ Date	**Vary with RFQ**	**NA**	**NA**	**Rule: DLD1**
Price	**Rs 21,200 (US$ 530) per Ton**	**NA**	**NA**	**Rule: BP1**

Weight of the ith attribute is $Wi, 1 \le Wi \le 100$ *optimized weight of ith attribute* $\overline{W} = \frac{\sum W_j}{w_i} \times 100$

Non-negotiable SAKB: Name and other information (general attributes) of the manufacturing Company / Stockiest dealt with products. (we represent Billets of SAIL, in our example).

Negotiable unit of SAKB: Collect RFQ (Refer to Fig 3)
Rule # QTO1 on quantity
Rule # DLD1 on Delivery_date
Rule # BP1 on Price

There may be more number of negotiable attributes in actual steel buying processes like payment terms, Value and cost , delivery outside state, landed cost and so on.

1.QTO1: IF (Quantity_Ordered > 100 metric ton) then
{Packing = (Quantity/5) bundles}

2.DLD1: IF (Order_Date == Current_Date) then
{Delivery_Date = Order_Date + 15 days }

3.BP1 : IF ((Quantity_Ordered 100 metric ton) then
{Price = Rs 22,200/- per ton + Delivery_Charge_at_site

else IF (Quantity_Ordered > 100 metric ton) then
{Price = Rs 21,200/- per ton inclusive of Delivery_Charge_at_site }

5.2 Examples of AKB involved in Auction

Before submitting tender for auction, the selling company provides a set of rules and regulations/protocols related to the auction process. These rules are the basis of the formation of the knowledge base of the corresponding negotiating agent. We give below such a template.

Table-2: Knowledge base Template for Auction of Steel

Attribute	Value	Weight	Optimize Weight	Negotiable
Steel Category	Refer to KB **Auction_ Schedule**	10	680	N
Date of Auction	Date	10	680	N
Letter of Interest	Refer to KB **Letter_of_Interest**	10	680	N
Conduct of online auction	Refer to KB **Service_Provider**	10	680	N
Terms of sales	Refer to KB **Sale_of_Materials**	10	680	N
Territory Obligation	Refer to KB **Service_Provider Annex-T**	10	680	N
Earnest Money	Demand draft of Rs 50,000/- or Rs 1,00,000/-	8	850	Y
Private Attribute				
Earnst_MONEY	DD	NA	NA	Rule :EMD1
Auction_Type	'All'	NA	NA	Rule :EMD2
Pim_cum_DO	'Payment Received'	NA	NA	Rule :PCD

Negotiable unit of SAKB
Rule # EMD On Earnest Money Deposited
Rule # PCD Plant instruction cum delivery order

1. **EMD1** : IF (Earnst_MONEY) ="DD of Rs 50000" AND (Auction_Type) ≠ 'All' THEN
{ Collection by the company at own cost + crane charges free}
ELSE
IF (Earnst_MONEY) ="DD of Rs 50000" AND (SO_ISSUED)="Yes" AND (ITEMS) not ="Found" THEN
{Fill the Refund claim in a specified form and submit +
collect Refund of security received without any interest}
2. **EMD2** : IF (Earnst_MONEY) ="DD of Rs 100000" AND (Auction_Type)= 'All' THEN
{Collection by the company at own cost + crane charges free}
ELSE
IF (SO_ISSUED) ="Yes" AND (ITEMS) not ="Found" THEN
{Fill the Refund claim in a specified form and submit +
collect Refund of security received without any interest}
3. **EL_SALE1** : IF (**EL_SALE**) =TAX_RETURN THEN
{Tax Concession to user is allowed}
ELSE
IF (**EL_SALE**) ≠TAX_RETURN THEN
{ Tax Concession to user is disallowed}
4. **PCD:**IF (Pim_cum_DO='Payment Received within seven daysfrom the date of sale-order') THEN
{Issue the delivery order }

5.3 A Knowledge Data Warehouse

Data warehouse is a subject oriented, integrated, time-variant, non-volatile collection of data for corporate decision making [4,5]. Subject oriented indicates discussion about some subject chain like procurement, production and sales of a product of an enterprise. Integrated indicates data of a particular subject from all possible sources, irrespective of its homogeneity or heterogeneity in nature like package for heart operation includes: Operation Theatre charge, cost of Surgeon, Medicine, Pathological charges etc. Time variant means data about past events which provides information for the present instance. Nonvolatile indicates no transaction processing, no updating only data loading and accessing is allowed.

History is generated out of AKB's processes in a Data Warehouse. Yuan Ji in 2001, in his report [7] describes a framework of a data warehouse implementation for automatic translation of the data model into XML format. A Multidimensional Data Query language (XMDQL) along with different application program interfaces (API) is described. To categories the three different kinds of query on the warehouse like warehouse query, Cube Schema Query and cube data Query is described. However, Inmon criticized the significant disadvantages of the virtual approach of the data warehouse [5]. OLAP (Online Analytical Process) is a set of measures used to analyze the data of Data Warehouse.

To view the contain measures are like; Roll-up, Drill-down, Slice, Dice and Pivot. Functional data is modelled and stored separately in a Data Warehouse.

VI. CONCLUSION AND FUTURE WORK

In this paper the procurement process with the help of agents and their knowledge bases are described mainly with the help of static and dynamic templates for a steel buying process. In section II, we use the UML diagrams then section III to section IV, we gradually developed the concept of agent knowledge base and finally the concept of Data Warehouse is introduced. It is an based on Object Oriented Analysis and Design (OOAD).However, the architecture of the agent knowledge base in the Data Warehouse is abstracted from this paper due to complexity and length of the paper. Now the business over the net is just not the communication only. It is also a question of availability of resources any where and at any time. So the business on the cloud demands distributed agents and the corresponding warehouses. So we propose to extend and model a generic frame work of procurement over a distributed environment in a e-market place.

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Authors Profile

Mr.Rahul Karmakar pursed Bachelor of Technology from Westv Bengal University of Technology, India in 2006 and Master of Technology from University of Calcutta in year 2009. He is currently pursuing Ph.D. and currently working as Assistant Professor in Department of Computer Sciences, Department of Computer Science, The University of Burdwan,India since 2014. He is a member of ACM & ORSI since 2017, a life member of the CSI and ISCA since 2017. He has published more than 10 research papers in reputed international journals and conferences.His main research work focuses on Software Engineering, Formal Methods and Model Checking. He has 10 years of teaching experience and 3 years of Research Experience.

Mr. Bidyut Biman Sarkar *is* an Associate Professor in MCA Department of Techno International New Town. He received his MSc. Degree in Applied Mathematics and Ph.D degree in CSE form University of Calcutta. Dr. Bidyut served IT industry in India,Singapore,Thailand and other south Asian countries for more than 20 years. He has published more than 20 research papers in reputed international journals and conferences including IEEE and it's also available online. His main research work focuses on Distributed Computing, Software Engineering, Big Data Analytics, He has more than 15 years of teaching experience and 10 years of Research Experience.

Mr Nabendu Chaki is a professor in the Department of Computer Science and Engineering, University of Calcutta. His research interests include Distributed Computing and Software Engineering. Dr. Chaki has supervised in the Ph.D. program in Software Engineering in Naval Postgraduate school,Montery,CA,USA during 2001-2002. As a research Assistant Professor. He ia a visiting faculty member of many Universiyies including The University of Ca'Foscari,Venice,Italy. Besides being in the editoril board member of various International Journals, Dr. Ckaki is a KA Editor of SWEBOK guide V3 of IEEE Computer Society. He has also served in the commettees of several International conferences.He is a member of IEEE & IEEE computer society, ACM,CSI and ISCA. He has published more than 150 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences including IEEE and it's also available online.. He has more than 15 years of teaching and Research Experience.

