Modeling of Supply Chain Management Using Multi-Agent Collaboration Engine And Reduction In Bullwhip Effects

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Abstract- *Information technology based solution frameworks provides a path for effectively integrate the process of decision making by enabling enhanced knowledge and providing more transparent economic translations. For the improvement of Supply chain Management (SCM) performance, agent technology is progressing as the best alternate. In general term, approximately all the components in SCM work in seclusion and achieving coordination among Supply Chain Management partners turns out to be a difficult proposition . But in a multi-agent system (MAS) , while an agent tried to make a local optimal decision , it found the effects with other agents and also coordinates with other agents to refine for a new alternative . In SCM, how to improve the performance? Today SCM required to works with contribution of various minded organizations to produce and supply to multiple market. In such circumstance MAS, with beneficial features like autonomous, collaborative, coordinate and intelligence with ability to work in a distributed environment provides a best platform to make SCM performing at its best . Bullwhip effect is the magnification of demand fluctuation, not the magnification of demand. Whenever the demands increase/decrease, the bullwhip effect is evident in a supply chain. Some of the bullwhip effects are excess inventories, quality problem, increase in costs, overtime expenditure, lost customer services and many more. This leads to poor forecasting of sales, incorrect information among the supply chain. The main aim is to propose an integrated frame work based on multi-agent collaboration and case-based reasoning that can resolve various collaboration issues in supply chain and develop a supply chain management application based on MAS and build a model how it can help in reducing bullwhip effect in a manufacturing unit. To justify the frame work's feasibility, we implement a prototype system (multi-agent collaboration Engine supply chain management) MACE-SCM.*

Keywords- MAS (Multi Agent System; CBR (Case-Based Reasoning); RDQL (Retrieval Data Query Language); MACE (Multi Agent Collaboration Engine);

I. INTRODUCTION

An information based society decides associations to concentrate their exercises on enhancing administration quality by utilizing learning. Gigantic information stores end up plainly vital once the genuine criticalness of information is found. Over the previous decade, case-based thinking (CBR) has developed as a noteworthy research range inside the computerized reasoning examination field because of the two its across the board use by people and its allure as a philosophy for building keen frameworks. All the more as of late, there has been a scan for new ideal models and headings for expanding the utility of CBR frameworks for choice help. There is a synergism between the exploration territories of Data Mining, CBR System, Multi-operator System and choice emotionally supportive networks (DSSs) to take care of numerous modern issue including Supply chain issues. A calculated structure for DSSs in light of MAS utilizing DM and CBRS is as of now existing to take care of everyday issues. These days, clever specialists speak to a critical chance to upgrade learning administration.

To enhance the execution of Supply chain choices (SCM), operator's innovation is gradually turning into the best option. When all is said in done, the vast majority of the segments in SCM work in separation and accomplishing coordination among SCM accomplices ends up being a troublesome suggestion. In any case, in a multi-specialist framework (MAS), an operator while settling on a nearby ideal choice, it perceives how it will impact alternate specialists and on the off chance that required it facilitates with different specialists to exercise for another option. The task intends to propose a coordinated casing work in view of multi-operator joint effort and case-based thinking that can resolve different cooperation issue in store network. To demonstrate the casing work's attainability, we execute a model framework (multi-operator cooperation Engine inventory network administration) MACE-SCM.MACE-SCM gives more adaptable and extensible answer for help address rising vulnerabilities.

A reconciliation of MAS, CBR and SCM capacities incorporates the outcomes to acquire the coordinated gauge. Coordination Module at that point takes this incorporated figure as the base of circulation arranging, and gives an insignificant framework wide aggregate cost answer for all gatherings in the production network. All in all, this MAS+CBR+SCM design is foreseen to give an effective component to community oriented request arranging, and help make the most extreme benefit for the production network.

We propose an edge work multi-operator coordinated effort Engine inventory network administration (MACE-SCM) which gives more adaptable and extensible answer for help address rising complex issues in SCM. In any case, the progression of the venture and the market make this troublesome: bank rates change overnight, political circumstances change, materials don't land on time, generation offices come up short, specialists are sick, clients change or wipe out requests, and so forth. Under these conditions a MAS + CBR based SCM would be the best arrangement and we endeavor to demonstrate our point in this examination work.

2. WORK RELATED TO CBR AND MAS

An agent is an entity that is capable of working in an environment by communicating with other agents with the capability of perceiving. Agents are autonomy that is capable to do at least part of its some specialized in one or many more application areas. Agents are reactively participating to inputs from their experience. They are goal oriented. Agents have the capability to change in their behavior as per the conditions changes in an environment. Crucial features related to agents are they are communicative and cooperative.

Multi Agent System are systems in which more than one agent perform their functionality together to solve the complex organizational problems related to Decision Making System.MAS know when and how to took decision for better performance. MAS have the characteristics of inherent distribution, flexible nature and complexity. Those characteristics are the reasons of speed enhancement and scalability and reusability. In MAS each agent has incomplete information. Data and controls are decentralized. Several issues are addressed in designing the MAS

a)   When and how agent should interact
b)   How to decompose their task between several agents.
c)   How to enable agents for communication.
d)   Which language and protocols should be used?

e)   How to enable the agents to handle the conflicts.
f)   How ensure the correctness of MAS.
g)   How to define the role of each agent.

As the demand increase for more powerful and versatile agent, it too create pressure on developer. At the same time making agent performs many tasks that leads to the complexity of development and increase of maintenance agent are generally designed with a specific purpose in mind.

I. AGENT TECHNOLOGY APPROACHES IN SCM

MAS offer many new perspectives as compared to conventional, centrally organized architectures in the scope of SCM. Its structure meets the requirements of decentralized supply chains while conventional SCM are restricted to their dynamic behavior and handling severe disturbances at supplier sites as well as dealing with highly complex products. As compared to the existing SCM system the integration of numerous MAS performs successfully in both inter and intra organization. The global optimization of business processes offers a vast optimization potential. On the other hand various problems are faced like fluctuating demand creates the problem of bullwhip effects.

II. CASE BASED REASONING SYSTEM

Case-Based Reasoning (CBR) is a generally late critical thinking strategy that is drawing in expanding consideration. Be that as it may, the quantities of individuals with direct hypothetical or down to earth involvement of CBR is still little. The fundamental goal of this survey is to give an extensive review of the subject to individuals that are new to CBR.A case-based reasoner takes care of new issues by adjusting arrangements that were utilized to take care of old issues. The procedures engaged with CBR can be spoken to by a schematic cycle

a)   Recover the most comparative case(s);
b)   REUSE the case(s) to endeavor to tackle the issue;
c)   Update the proposed arrangement if important, and
d)   Hold the new arrangement as a piece of another case.
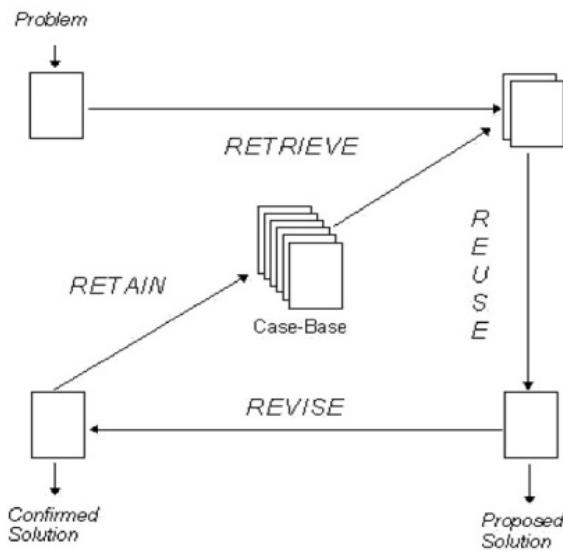
[Figure Adapted from Aamodt & Plaza, 1994]

Case Representation Techniques

a) Indexing

Case ordering includes doling out files to cases to encourage their recovery. A few rules on ordering have been proposed by CBR specialists.

b) Storage

Case stockpiling is an essential perspective in outlining productive CBR frameworks in that, it ought to mirror the theoretical perspective of what is spoken to for the situation and consider the records that describe the case. The case-base ought to be composed into a sensible structure that backings proficient pursuit and recovery strategies. An adjust must be found between putting away strategies that safeguard the semantic extravagance of cases and their records and techniques that improve the entrance and recovery of significant cases.

c) The dynamic memory show

The case memory display in this technique is included memory association bundles or MOPs. MOPs are a type of edge and are the fundamental unit in powerful memory. They can be utilized to speak to learning about classes of occasions utilizing two sort of MOPs.

d) The class model

This model sorts out cases in light of the view that this present reality ought to be characterized extensively with cases being alluded to as models. The case memory is a

system structure of classes, semantic relations, cases and file pointers. Each case is related with a classification. Diverse case highlights are appointed distinctive significance in depicting a case's participation to a classification.

e) Retrieval

Given a depiction of an issue, a recovery calculation, utilizing the records for the situation memory, ought to recover the most comparative cases to the present issue or circumstance. The recovery calculation depends on the files and the association of the memory to guide the pursuit to conceivably helpful cases.

f) Nearest neighbor

This approach includes the evaluation of likeness between put away cases and the new info case, in view of coordinating a weighted entirety of highlights. The most serious issue here is to decide the weights of the highlights. The restriction of this approach incorporate issues in meeting on the right arrangement and recovery times. By and large the utilization of this strategy prompts the recovery time expanding straightly with the quantity of cases. In this way this approach is more compelling when the case base is generally little. A few CBR usage have utilized this strategy to recover coordinating cases, for instance: BROADWAY for determination of auto models.

$$\frac{\sum_{i=1}^{n} w_i \times sim\left(f_i^I, f_i^R\right)}{\sum_{i=1}^{n} w_i}$$

A Nearest Neighbor Algorithm

g) Induction

Enlistment calculations (e.g. ID3]) figure out which highlights do the best employment in segregating cases, and produce a choice tree sort structure to compose the cases in memory. This approach is helpful when a solitary case include is required as an answer, and where that case highlight is reliant upon others.

h) Knowledge guided enlistment

This technique applies information to the acceptance procedure by physically distinguishing case includes that are known or thought to influence the essential case highlight.

This approach is every now and again utilized as a part of conjunction with different systems, on the grounds that the informative learning is not generally promptly accessible for expansive case bases.

i) Template recovery

Layout recovery restores all cases that fit inside specific parameters. This procedure is regularly utilized before different strategies, for example, closest neighbor, to constrain the pursuit space to a pertinent area of the case-base.

j) Adaptation

Once a coordinating case is recovered a CBR framework ought to adjust the arrangement put away in the recovered case to the necessities of the present case. Adjustment searches for unmistakable contrasts between the recovered case and the momentum case and after that applies formulae or guidelines that consider those distinctions while recommending an answer.

A case based thinking (CBR) framework is a fantastic choice particularly in an application situation where choices must be taken immediately. CBR framework encourages in giving answer for any issue from its case base. An issue is lessened to a case arrangement and CBR framework searches for a coordinating arrangement or close

MULTI- AGENT (M-A) COLLABORATION ENGINE FOR SUPPLY CHAIN

Keeping in mind the end goal to influence SCM to perform adequately, its capacity works in a facilitate way. Be that as it may, the quick difference in the venture and the market make

arrangement. This decreases time and exertion gigantically. New case with arrangement will be added to Case base once the arrangement in adjusted.
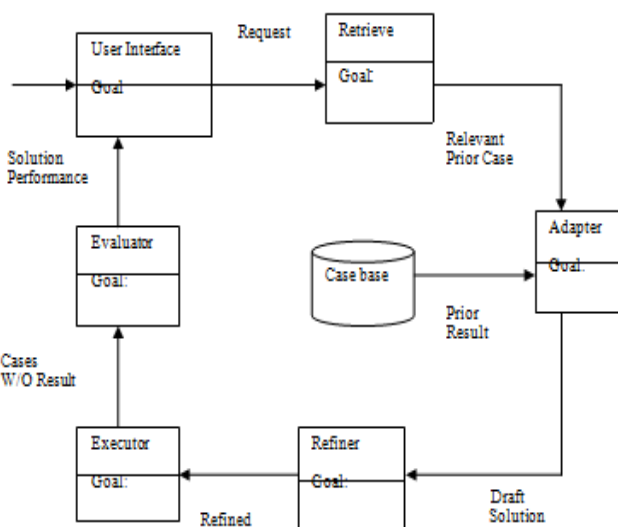
1. Retriever Agent: In which When another issue is gone into a case based framework, a retriever settles on the highlights like the put away cases. Recovery is finished by utilizing highlights of the new cases as records into the case base.
2. Adapter Agent looks at the contrasts between these cases and the current problem.It at that point applies standards to alter the old answer for fit the new issue
3. Refiner Agent evaluates the adjusted arrangement against earlier results. One approach to do this is to contrast it with comparative arrangements of earlier cases. On the off chance that a known disappointment exists for a determined arrangement, the framework at that point chooses whether the similitudes is adequate to presume that the new arrangement will fizzle.
4. Executer Agent acts once an answer is investigated; an executer applies the refined answer for the present issue. CBR framework comprises of Case base and motor comprising of these operators.
5. Evaluator Agent does the accompanying:

On the off chance that the outcomes are obviously, no further investigation is made, and the cases and its answer is put away or use in future critical thinking. If not, the arrangement is repaired.

SCM confronting a few troubles. Some of key issues are as per the following:-

1. Materials not arrived at required time due to shipment issues.
2. Production offices encounter down-time
3. Man power issue
4. Customer change request or wipe out.

Multi-specialist innovation has numerous gainful highlights for self-sufficient, community oriented and insightful framework in disseminated condition, which make it extraordinary compared to other possibility for complex production network administration. Within MAS, distinctive sorts of operators have diverse level of critical thinking abilities with in various issue spaces. MAS structures fluctuate as indicated by the multifaceted nature of issue areas (number of specialists, framework plan and the quantity of factors deciding operators, basic leadership conduct). Viable coordination systems consummating operator cooperation are especially required in any application particularly SCM. These ought to be dealt with at the plan of the framework itself.The proposed show is given beneath. The specialists are

objective situated. In the proposed models, Goals are debased for every specialist with their parts.

Manager Agent: - Goal of this operator is Maximum benefit giving to the organization and its capacity is Import amusement
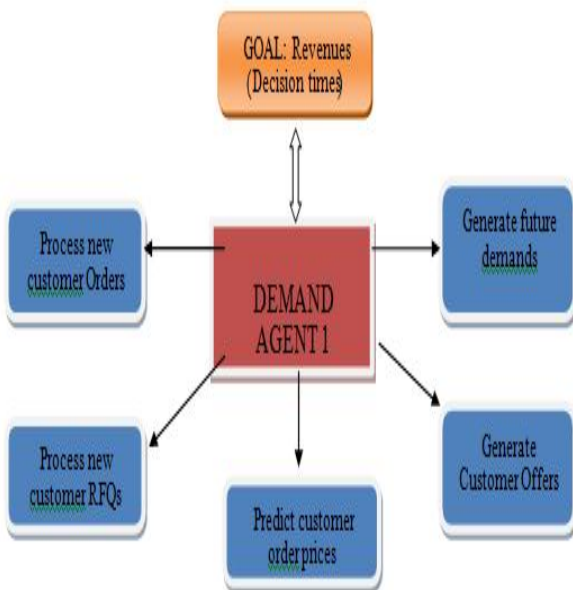
parameters, BOM and Component Catalog, Get provider offers, Customer RFQs and requests, Send and enlist, Client offers, providers' RFQs and so forth
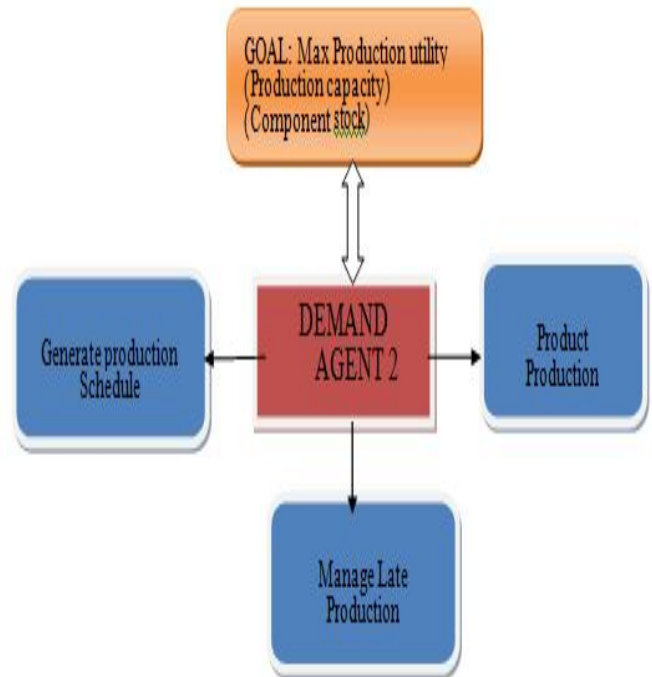

Figure: 1 Manager Agent

Request Agent:- Goal of this operator is Revenues(Decision times) and Max Production utility (Production capacity)(Component stock) work is Generate future requests, Process new client Orders, Predict client arrange costs, Process new client RFQs, Product Production, Manage Late Production, Generate creation Schedule.

Figure: 2 Request Agent1

Figure: 3 Request Agent2

Inventory Agent:- GOAL of this agent is Min component holding cost and function is Manage component, Product arrival & consumption, Manage Component Demand, Tune Component Stock Thresholds, Tune Component Critical levels, Predict customer order prices .

Figure: 4 Inventory Agent

Supply Agent :- GOAL of this operator is Min segment Cost and capacity of this specialist is Generate Supplier RFQs, Decide on amount And future date for provider, Track Supplier Prices and Deliveries, Generate Supplier Orders, Process Supplier Offers.
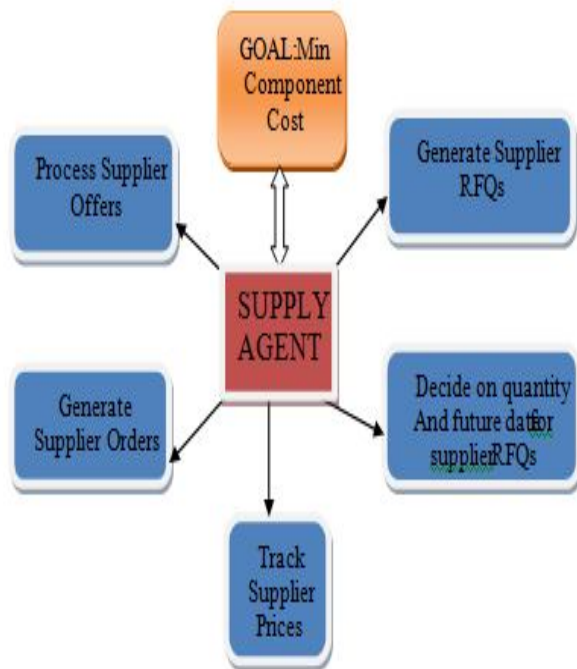

Figure: 5 Supply Agent

Delivery Agent: - GOAL of this agent is Min Component Holding Cost and Function of this agent is Generate Deliver Schedule, Manage Late Customer Orders.

Figure: 6 Delivery Agent

Booking Agent: - GOAL of this operator is each procedure is finished inside a sensible time system and Function of this specialist is Customer benefit administration process,

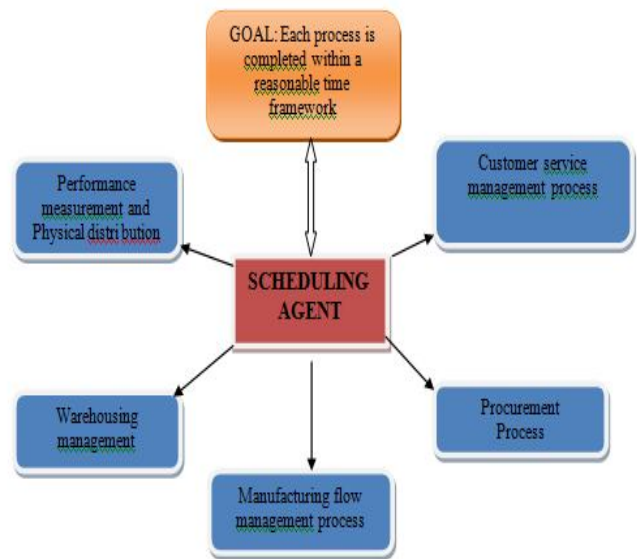Procurement process, Manufacturing stream administration process and so forth.

Figure: 7 Booking Agent

Request handling Agent: - GOAL of this operator is each procedure is finished process from purpose of offers request to conveyance and Function of this specialist is the idea of the requests, Availability and cost and efficiency of workforce, the nature of the requests, Predictability of future volume, item and request profiles, and Seasonality varieties in outbound volume.
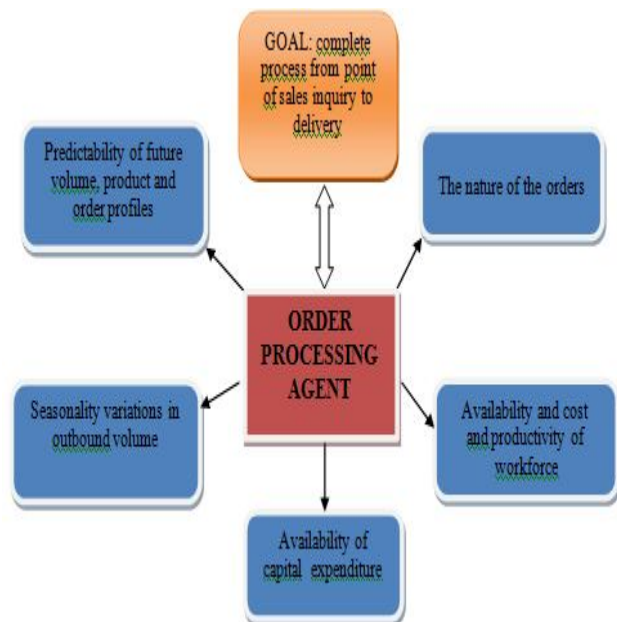

Figure: 8 Request Handling Agent

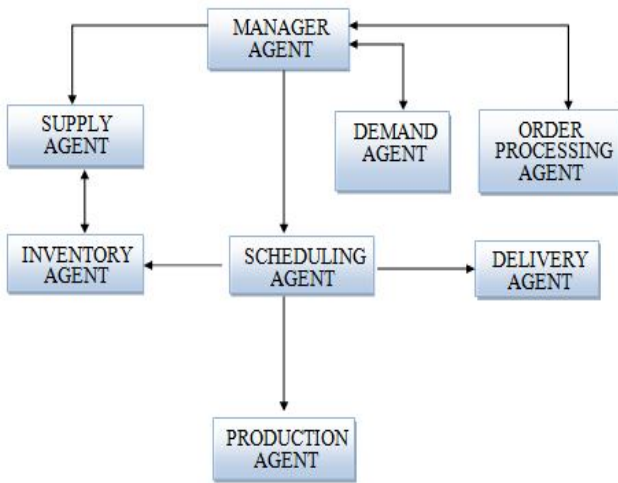Relation between agent and the information and controlling of processes in particular order in this system which is purposed.

Figure: 9 Flow of information and control
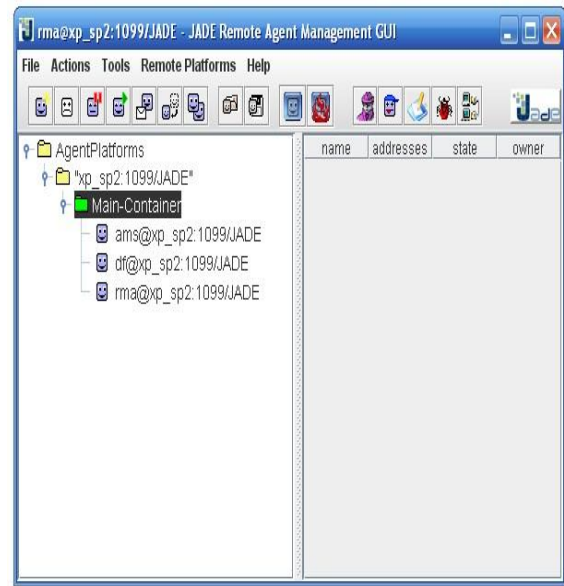
1. Frame Work

In this Frame work the first case is look at by the RDQL (Retrieval Data Query Language) if this case exist at that point specifically achieve the aftereffect of past case other insightful proceed onward adjusted case and Check out by RDQL again if its discover at that point demonstrate result straightforwardly other shrewd proceed onward comparable Assessment.
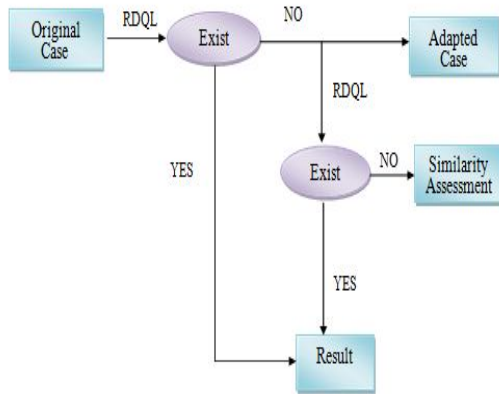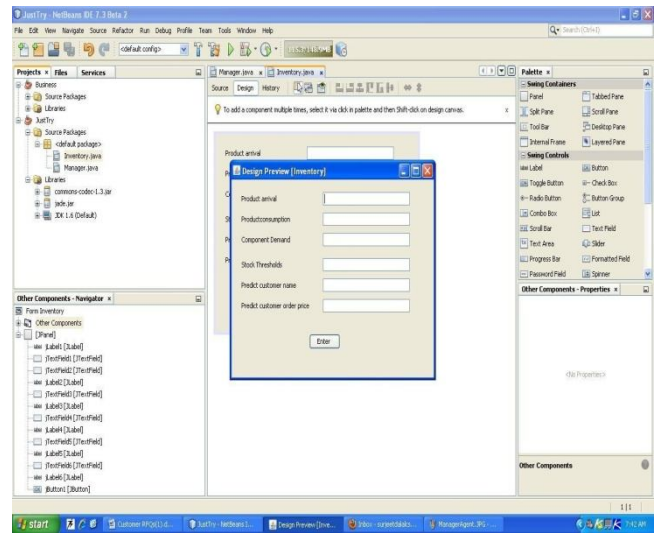

Figure: 10 Framework

2. BULLWHIP EFFECT REDUCTION

Supply Chain involves all those activities needed to design, manufacture and deliver a product or service needs a mechanism of framework for information sharing. Agent based manufacturing is a new way of thinking about and applying information. With such idea an effort is made to

provide a multi agent system model for the supply chain management in order to reduce the bullwhip effect.

Figure: 11 GUI of the JADE RMA

Figure: 12 Manager Model

In a proposed model each agent performs a specific function of the organization and share the information with information agent. There by most important requirement of successful supply chain information sharing is achieved besides controlling the demand supply trouble in the proposed model.

III. CONCLUSION AND FUTURE WORK

Supply Chain Management (SCM) has become a vital issue for manufacturers, professionals and researchers.It is felt that to manage the supply chain effectively complete structure of supply chain must be understood properly.Supply

chain management is to integrate. SCM required to integrate all activities like sourcing, procurement, production scheduling, order processing, inventory management, transportation, manufacturing, warehousing, and customer services. Research suggests that integration of several functions at different organizational levels could give above average financial and performance results. There is a continuous need to interact with supply chain partners to achieve the basic objective of organization. MACE-SCM provides more flexible and extensible solutions to help address emerging uncertainties in Supply Chain Management. The importance of collaboration in the supply chain has led researchers to suggest diverse approaches for problems in the collaboration process. Now these are the challenges for SCM

➢ Which technology is best?
➢ When coordinating and sharing information in the presence of various supply and demand uncertainties.

Given a complexities of supply chains we propose a frame work based on case based reasoning approach to build a complete comprehensive multi agent system to understand, manage and make informed decision to minimize disruption in SCM. CBR emphasizes problem solving and learning as two sides of a coin: problem solving uses the result of past learning episodes while problem solving provides backbone of experience from which learning advances. The development of the trends of CBR could be grouped around four main topics

➢ Integration with other learning methods.
➢ Integration with other reasoning components.
➢ Incorporation in to massive processing.
➢ Method advanced by focusing on new cognitive aspects.

This paper will enable Next-Gen computing especially in the software field which requires much attention in the computer field. Building Autonomous Agents is a challenging task which is essential for our main project MACE-SCM. The main problem in the industry is to reduce the cost of production and increase the revenue. This aim of the project is to provide a solution to the industry so that the industry will grow on at faster speed.

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