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Quantification of Dynamic Business Environment by Development of Ontology using Task Reduction

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Abstract— The paper highlights the use of Multi-Agent Task Reduction technique in developing a framework for Dynamic Business Environment. It uses the concept of problem decomposition in dynamic environment. It provides a framework which can support sustainable environmental impact of goods and processes, beginning from extraction of raw materials to the final movement of end product.

Index Terms— Business Dynamics, Multi-Agent Systems, Onto-logics, Task Reduction, Workflow Management, SCM, Porter's Value Chain, Descision Support System.

1 INTRODUCTION

A real intelligent agent is proving to be very useful in the real world. It supports the features of building an expert system which is helping in problem solving complex problems. This paper provides ontological Agent collaborations of Internet Marketing, it supports expert knowledge based features in finding the right product from the large repository of product database. This can only be possible if the product is readily available with the supplier. SCM (Supply Chain Management) provides holistic approach acting as a bridge between major business functions and business process within and across companies. Information system provides an effective backbone in managing the supply chain using softwares like ERP and Decision Support System.

2 . LITERATURE REVIEW

Faisal et al[1]present an approach to effective supply chain risk mitigation by understanding the dynamics between various enablers that help to mitigate risk in a supply chain. Cucchiella and Gataldi [2] individualize a framework for the management of uncertainty in supply chain finalized to reduce the firm risks. Tang [3]reviews various quantitative models for managing supply chain risks and develops a unified framework for classifying SCRM articles. Wu et al. [4]reinforce inbound supply chain risk management by proposing an integrated methodology to classify, manage and assess inbound supply risks. Gohet al. [5] present a stochastic model of the multi-stage global supply chain network problem, incorporating a set of related risks, namely, supply, demand, exchange, and disruption.

Ritchie and Brindley [6] purpose to examine the constructs underpinning risk management and explores its application in the supply chain context through the development of a framework. Khan and Burnes [7] developed a research agenda for risk and supply chain management. These authors show that there are a number of key debates in the general literature on risk, especially in terms of qualitative versus quantitative approaches, which need to be recognized by those seeking to apply risk theory and risk management approaches to supply chains. In addition, they show that the application of risk theory to supply chain management is still in its early stages and that the models of supply chain risk which have been proposed need to be tested empirically. Li and Chandra [8] investigated and developed a generic knowledge integration framework that can handle the challenges posed in complex network management. Williams et al. [9] develop and present a categorization of supply chain security based on existing research. Olson [10] proposed a supply chain model and use simulated data with representative distributions. The results show that the proposed approach allows decision makers to perform trade-off analysis among uncertainties. They also provide alternative tools to evaluate and improve supplier selection decisions in an uncertain supply chain environment. Rao and Goldsby [11] review the growing literature examining SCRM and to develop a typology of risks in the supply chain.

3 DECISION SUPPORT SYSTEM

The basic idea is to provide a framework which can support sustainable environmental impact of goods and processes, beginning from extraction of raw materials to the final movement of end product.

The evolution of supply chain is very gradual starting from Mazumdar and Balachandran (2001) supporting three stage evolutionary process. Later on Ballon (2007) divided SCM into three periods, Past, Present and Future. Foremost advantage of SCM is its close collaboration with internet market and industry. Internet market is a platform where buyer and seller exchange information, do the transaction to satisfy both of them. The concept of Multiagent was started by (Fazel Zarandi et al., 2007) stating that "the main interest of managers is to ensure that the overall cost is reduced and operations among various system are interchanged through coordination". Fox, Barbucaen and Teigen, 2000 also supported Agent Application in distribution, collaboration, autonomy and intelligence.

3.1 Introduction toSupply Chain Management

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials,

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transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains[1,2,3,4,67,8,9] exist both in service and manufacturing organizations. Realistic supply chains have multiple end products with shared components, facilities and capacities. Usually, business unities along a supply chain operate independently, having their own objectives that are often conflicting with each other. Therefore, an essential condition to the success of a company is the conception of a strategy for coordinating the several business unities in a supply chain, leading to an effective management at strategic, tactical and operational levels. The efficiency of a supply chain is influenced by several factors, such as: stock management, production planning, production costs, scheduling and distribution strategies, and customer-specific demand, among others. Planning and modelling the production, stocking and distribution systems of a supply chain is an important support for decision making in a competitive market. According to Dong [13], the several approaches for modelling and optimisation of a supply chain can be classified into five classes:

- Project of the supply chain
- Integer-mixed programming optimisation
- Stochastic programming
- Heuristic methods
- Simulation-based methods.

Modeling a supply chain has the following two purposes: to analyse the dynamics of the supply chain so as to identify strategies that minimise its dynamics[14,16,19]; and to validate an accurate model that represents a supply chain. Conventional numerical optimisation methods in supply chain design can get trapped in local maximum due to hill-climbing. Several problems of supply chain optimisation arise from difficulties in applying calculus-based analytical methods to parameter optimisation under constraint conditions. Further, the objective functions needed in these numerical methods must be 'well-behaved'.

In most organizations, supply chain planning is the administration of supply facing and demand-facing activities to minimize mismatches, and thus create and capture value requires a cross-functional effort. A framework on supply chain planning in SCM is shown in Figure 1.

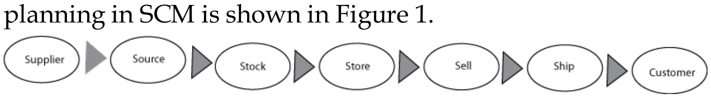


Fig. 1. Basic Supply chain planning steps

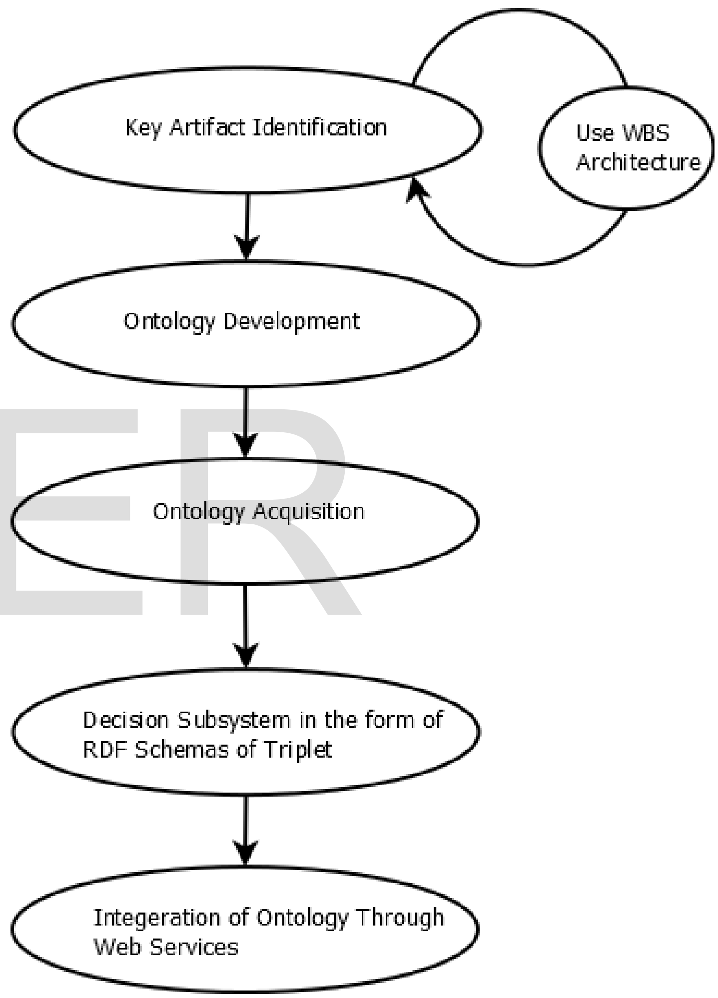
Supply chain planning is focused on synchronizing and optimizing multiple activities involved in the enterprise from procurement of raw materials to the delivery of finished products to end customers Genetic algorithms and artificial neural networks have been applied to derive optimal solutions for collaborative supply chain planning.

The basic idea of intelligent Agent is to develop a framework supporting knowledge conceptualization and representation. Since supply chain and its linking is a very complex issue we use the concept of Task Reduction in solving this problem. A fundamental and powerful concept of problem solving and simple representation states that if 'P' is a problem than it can be reduced into simpler problems P1, ..., Pn. The solution S1, ..., Sn of the problems P1, ..., Pn can be combined into a solution S of P.

Minsky 1985 described intelligent agent as "An expert system that perceives its environment and finally draw inferences, to realize the set of goals."

Task reduction plays a crucial role in development of Multi Agent Systems. (Uma, Prasad and Kumari, 1993) described the various phases of Multi Agent Systems:

- Problem decomposition
- Sub-problem decomposition
- Sub-problem solution



- Sub-problem integration

Fig. 2. Work Breakdown Strategy in Ontology Development

The term "Task" is used to represent problem and for reduction of any task to any sub-task, it is essential to pinpoint the element of knowledge focusing on problem solving issues of the "Task".

In this methodology required problem solving steps, consists of

- Name of task
- Question relevant to the solution
- Sub Task or solutions identified by proceeding task

Each task has its associated solution, and these solutions are integrated from bottom to top. This integration of solution moves up to form a final solution i.e. S1 (Figure 3)

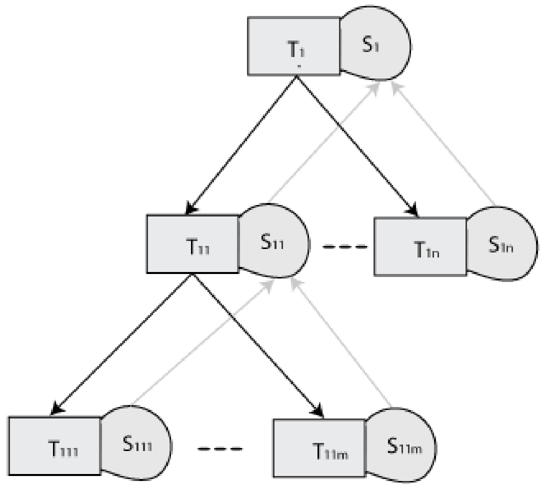


Fig. 3. Task reduction diagram (Adapted from Michael Bownran, 2007).

In order to streamline the process of Internet Marketing and Supply Chain we use Porter's value chain creation. Porter value chain links the final selling of the product with a relationship in product with a relationship in product design concept.

3.2 Primary Activities of Porter's value Chain

Inbound logistics: It refers to the inventory being procured from the vendors.

Operations: All the activities/process involved in generation of final product is a part of Operation.

Outbound logistics: All the distribution channels available for selling the finished goods like distribution centres, wholesalers, retailers or customers.

Marketing and Sales: It deals with all the marketing mix is for promoting the product in the market.

Services: All the supporting activities which is a part of the after sales and services is a part of services.

All these activities provide an excellent "competitive advantage" defined by Porter.

The protocols for interconnectivity provided through Supply Chain Management can be defined as in Figure 5.

The Agent lifeline in sequence diagram (figure 4) defines the period during which the buyer or seller Agent exists. These lifelines also support two kinds of behaviors: parallelism and decisions supported by XOR operator (figure 6).

It depicts the condition that only one output is allowed. The single Agent lifeline which ends up only after completion of particular operation is shown by interleaved protocols. In order to verify any operation we use two kinds of action parameters <<proactive>> and <<reactive>>. For example the buyer can only purchase the product when it is available in the stock.

{[public][Stock=n] Buying Process [(Item, lists)][Stock = n-1]}

Now we have to work on business dynamics, the first step will be to find out the Task (Question-Answer) and then derive an Ontology which can be improved as required. Finally we are developing a Solution Tree which is a Formalized Solution set. The elaborated tree of the entire solution can be designed as:(figure 7)

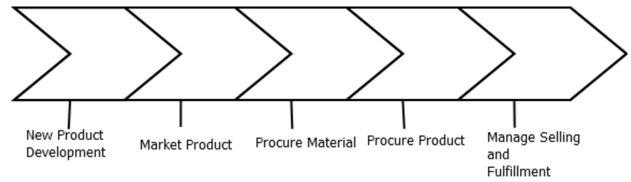


Fig. 4. Porter's value chain model

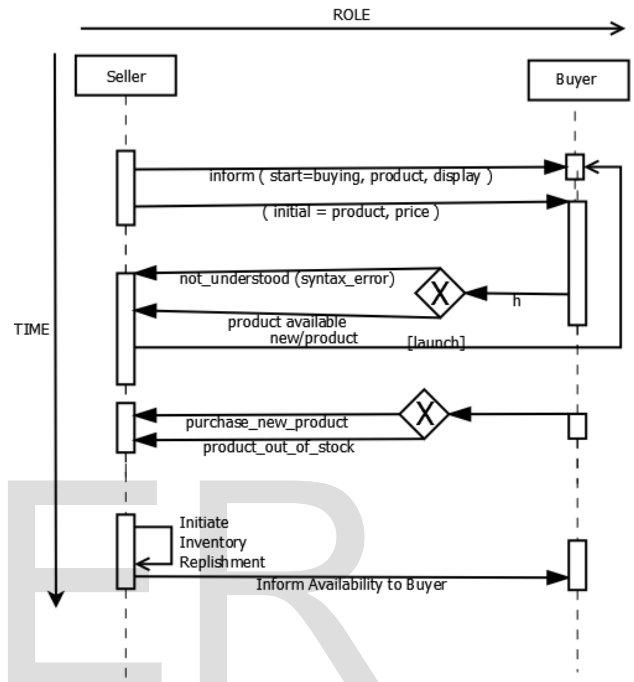


Fig. 5. Protocol diagram of buyer and seller

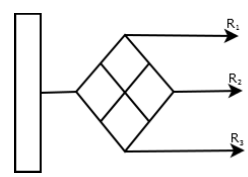


Fig. 6. XOR operator

We can summarize the entire process of Task Reduction Ontology as:

$T_{11}Q_{11}\{(A_{111}, OI_{111}, T_{111})\ldots(A_{11m}, OI_{11m}, T_{11m})\}$

We are able to generate language to logic translation of integration ontology with transition state as:

$[K_T = \{T_T Q_T(A_T, OI_T, S_T)\}]$

$$Smooth\ flow\ of\ Product\ (T_1) = \{Coordination\ of\ Buyer\ Ontology\ and\ Seller\ Ontology\}$$

The task reduction[16],[17],[18],[20] ontology generation method is best method for finding the solution for complex problem. It defines logical set of steps that reduces it into less complex problem. Figure 7 is graphical plot of breaking down into two steps: The first step deals with initial domain modeling while second step deals with initial ontological development. Using WBS[19],[23],[24] we are able to identify Ontological specification, state information and expert reasoning. The new information is represented in the form of Question, Answer and Transition.

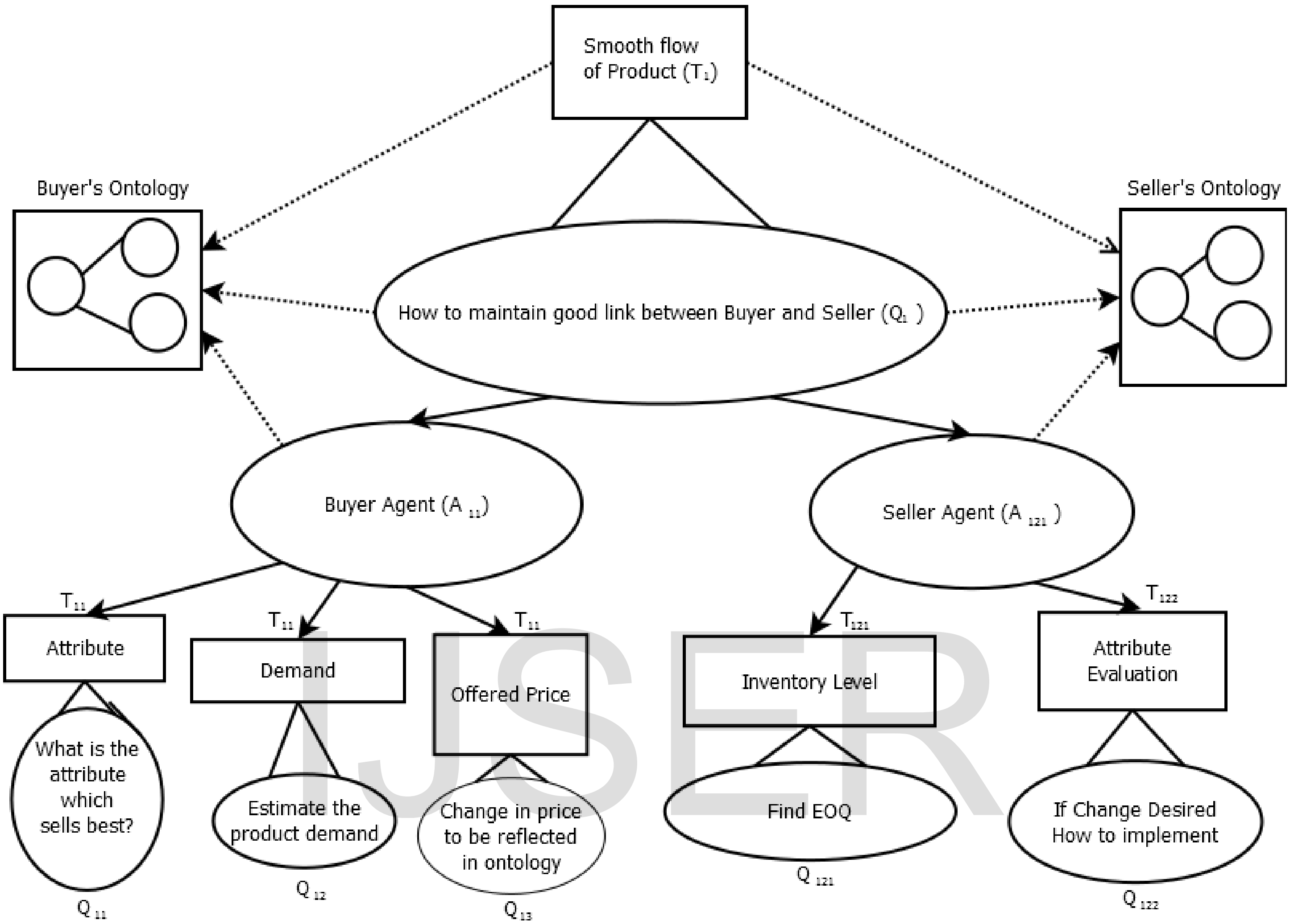
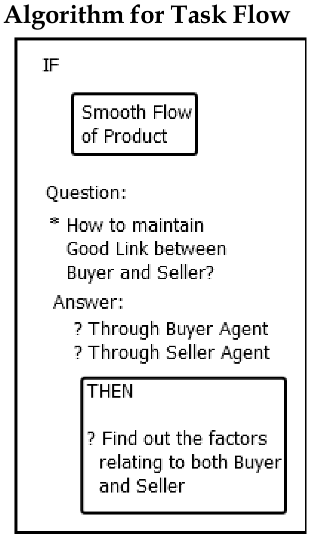


Fig. 7. Buyer Seller Task Reduction Ontology

Algorithm for Task Flow



The above process can be converted into necessary RDF showing a combination of Business fluctuations[26] in the form of inward demand flow and external product development. Any change can be formed by the help change in RDF modeling, which can be shown by the Algorithm-I as.

Algorithm-I:

1: Seach(A, OI,T) {A is a service node answer, OI is a set of Ontology of required operationor data, T is another set of transition}

2: if (OI, T = = A) return OI; {match of the requiste Ontology is found}

3: if (OI, T <> ∅) {Current node does not cover the required set}

4: N=Search for other sub node = Children_database(r); for all n∈N OI=(AT); {The search will be performed on the external Ontobase}

If (N<>NULL) return OI initial;

Return NULL;

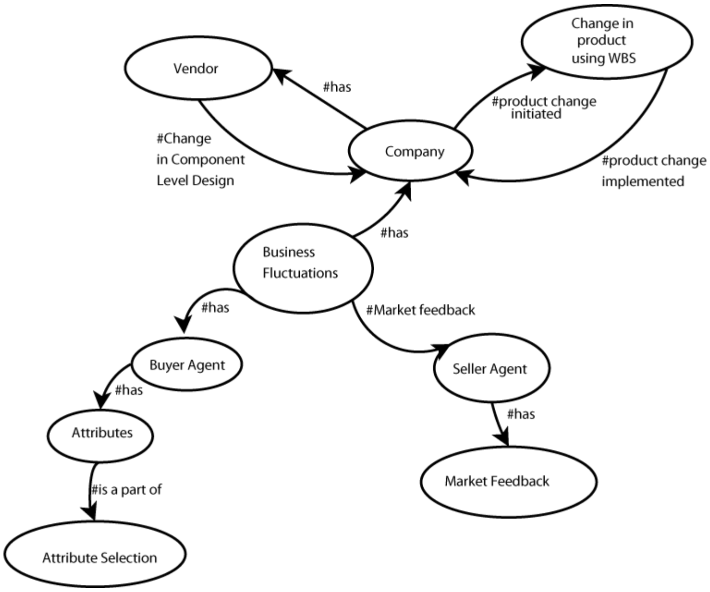


Fig. 8. RDF for Business Dynamics

The above algorithm[20], [21], [22], [25] starts with generation of search for the appropriate solution. The WBS strategy searches all the possible outcomes and integrates it with final result, generating the required ontology.

4 . VERIFICATION AND VALIDATION OF THE MODEL

The verification of the above framework for dynamic business environment and ontology change we use Petrinets as a tool to model the framework and validate it.

4.1 Petrinets

Petrinet are a well founded process modeling technique. It was invented by Carl Adam Petri in the sixties since then petrinets have been used to model and analyze all kinds of processes. In nineties petrinet has been extended with color, time and hierarchy. Although there are workflow techniques available but Petrinet has certain edge over then like:

- Formal semantics
- Graphical Nature
- Expressiveness
- Vendor Independence.

4.2 Sequence Pattern of Petrinets

A sequence pattern contains two or more ordered activities that are performed sequentially, i.e. an activity starts after a previous activity has completed. This pattern is easily implemented by means of the basic Petri Net constructs: for each activity a transition is created and the transitions are connected with each other by means of arrows and places.

In order to verify our model we have used Petrinet Simulator 2.0. It consists of an area known as PetriNet Document. PetriNet Document is consisted of three views: PetriNet Editor view, Description view and Response view.For our simulation we have used Response view (figure 9 & 10).

Figure 8 represents simulation of ANDing approach where the similar activities are grouped together depending on the validity condition. Any change in market feedback will result in “Change in Component Level Design” which needs to be supported by “Ontology Change” as it has to be supported by change in vendors and other process systems. The figure 9 can be further extended to figure 10 where each and every process is discussed in detail, till a final outcome in the form of change in consumer liking is being designed.

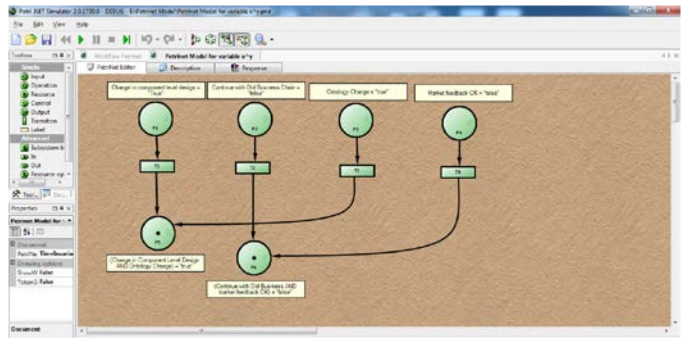


Fig. 9. Petrinet X^ Y Interpretation

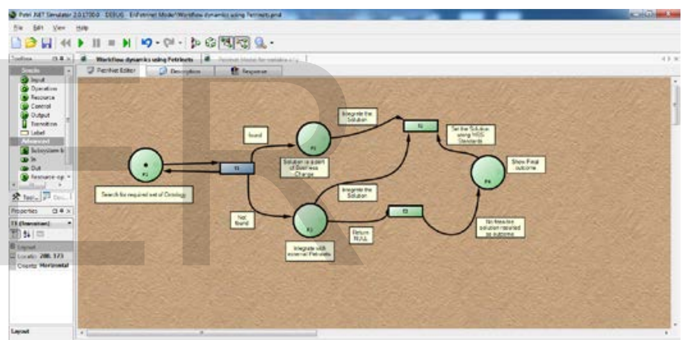


Fig. 10. Change in Ontology in response to Business Dynamics

5 . V. CONCLUSION

Multi Agent provides a strong base in the area of field of Software Engineering in order to deal with complexity of software systems. The architectural design of Multi Agent system is an attempt to formally verify the Real Time problem. Using the above approach we are able to model and implement all type of dynamic business situations including static ontology generation and dynamic ontology according to business rules. Using the concept of Petrinets we are able to formalise the situation. Future scope of our work will focus on extension of our work for automatic generation of business rules in terms of Ontology and Multi-Agent Language for a particular business domain.

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