

## Modeling Social Features and Dynamicity of Collaborative Business Process

Sara Parvaneh<sup>1</sup>, Ali Moeini<sup>2</sup>, Sohrab Sarafiabadi<sup>3</sup>

<sup>1</sup>Department of Management, Science and research Branch,  
Islamic Azad University, Tehran, Iran

<sup>2</sup>Department of Algorithm and Computation, Faculty of Engineering,  
University of Tehran, Iran

<sup>3</sup>Islamic Azad University, South Tehran Branch  
Tehran, Iran

<sup>1</sup>s.parvaneh@srbiau.ac.ir , <sup>2</sup>moeini@ut.ac.ir , <sup>3</sup>Sohrab.sarafi@gmail.com

**Abstract.** Social features and Dynamicity within Collaborative organizations are an important consideration for Participant. It is well known that with the absence of dynamicity, the organization could not adopt themselves with market demands. Therefore, the structure of processes must be modified. Furthermore, without explicit definition of social features, especially coordination, conflicts and deadlocks may occur in interoperability execution in organizations. The aim of this research is to provide a technique to improve social feature definition, adaptability and dynamic of a special collaborative organization with the use of petri nets. After that with a powerful tool and Occurrence Graph, it is evaluated. The result shows that with our approach, Organizations respond to the Customer's demand in a shorter time (Dynamicity), and deadlock is avoided with the use of decision policies (Coordination).

**Keywords:** Social features, Dynamicity, Hierarchical Colored petri net, Collaborative organization

### 1. Introduction

Nowadays, organizations are become more and more dependent to each other. Consequently, communication and interaction with Suppliers, sellers, customers and competitors is essential to survive [1]. As these collaborations are complicated and any mistakes have an irrecoverable effect on business processes, It is necessary to design a precise cooperative system among organizations. Commonly,  $n$  organization can participate in a general workflow. However, they have their own local workflow [2]. As cases must perform correctly, the organizations must be dependent each other. Therefore, local workflow processes must have mutual interaction. The general workflow consists of these local workflows and their interaction structure [8]. According to [8] there are different types of Interoperability: Capacity sharing, Chained execution, Sub contracting, and loosely coupled. In this article, we use chained execution which with the request of a customer, processes is being performed sequentially and sometimes concurrently.

On the other hand, business process management technology dealt with a lot of challenges according to dynamic environments of business organizations, in which requirements and goals are constantly changed [2]. Therefore, most users need a compatible and flexible model for managing their business.

In this paper, a system is designed for monitoring social behavior and As the organization must adapt with changes in customer's demands, A dynamic feature to the system with some modification is defined. This system is a simple supply chain which includes customer, supplier and producer. Finally, the soundness and reachability features of the system are evaluated by Occurrence Graph.

## 2. Related Work

In [5] a predicate/transition petri net is used for modeling processes and rules. Then they combine it into a heterogeneous PrT model which can simulate the behavior of a system.

In [6] the modeling of inter organizational processes is done by petri nets and pi calculus. In this paper, first with the use of petri nets local processes for each participant are modeled. Then the interaction between participants is modeled by Pi calculus.

In [7] first a supply chain is modeled with color petri net and then with defining different demands from customer the bullwhip effect is studied. According to the result, some performance is measured such as a sudden reaction in customer demands, changes in the level of supply in a proper time, change in inventory goods, the cost of a participant in the supply chain and so forth. However, the unlimited replenishing inventory is issued.

In [3] a dynamic framework for process management is proposed. In this framework first a conversion from UML to color petri net is performed and the OOpetri net is developed. Then a change management approach for runtime processes is introduced.

## 3. Social Entities and Interactions

From an abstract view, collaborative business process modeling can be considered as a social interaction among people. These people work together to form a social entity. Some aspects of social interaction are as follows:

- **Awareness.** This means that each organization must know about public processes of other organizations, in order to have an efficient cooperation [9].
- **Communication.** This aspect is a set of terms, which provide a share concepts business goals. And it can increase the interaction among people [10].
- **Coordination.** In general, efforts for collaborating and creating its model, and also determining the role of participants and organizing them lead to a structural coordination [9].
- **Collaborative decision making.** Collaborative decision making is a critical aspect where problem solving is the main focus [10].

## 4. Modeling Business Process in Supply Chain System

In this section, a simple supply chain is considered to study the interoperability of organizations and is modeled by hierarchical color petri net and CPN Tools. The supply chain consists of a customer, a supplier and one producer. Meanwhile for the simplicity and highlighting the importance of delivering goods in a short time and forming an order in each organization regarding customer order, only time and quantity of the order is applied. The proposed strategy is that the producer regarding to changes in customer demands and receiving orders from the supplier, adjust and control its Inventory. In other words, when the quantity of orders periodically is submitted, the producer must have a high level of dynamicity to respond rapidly to the orders.

In fig.2, collaborative business processes in the supply chains can be seen. It represents hierarchically. Each organization has its own local processes. That is performed in two modules or sub pages called supplier and producer.

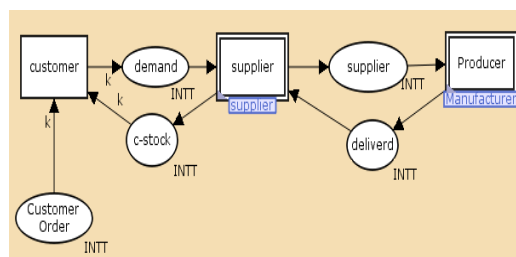


Fig.2 collaborative business processes

With similar definition for variables in binding elements, constant, places and tokens type, we can study the *communication* aspect of the model. With defining sockets in top page and connecting ports in producer and supplier sub pages, the transferring information can be done.

In the studied model, the *decision-making* is performed locally. So rules and strategies such as order and delivery functions can be done similarly with an agreement among organizations. Functions 1, 2, 3 show the decision strategy for delivery, reordering and replenishing inventory:

fun del(i,j)=if i>=j then i-j else 0; (1)

fun req(i,j)=if j>=i then i else j+(i-j); (2)

fun rep(i,j)=if i>j then j else i; (3)

Furthermore, *Coordination* in our model plays a key role, when all participants do their tasks and activities with the goal of increasing total benefit of supply chain system. For this reason time and guard controls in the model are used for coordination. With @+a and @+b in supplier and producer subpages we restrict our model to respond after 2 weeks (a=2 is defined in the declaration box of CPN Tools as a constant). Also with some guards on the transition, it is restricted to the execution of the guards, otherwise it does not activate. Without these guards and time it may leads to conflicts and deadlock and the coordination will be failed. Fig.3 shows the producer with decision making functions and coordination control. By the *Produce* transition, the received orders is transferred to *placing order* for storing the demand's quantity. This is important when four orders (z=4) or tokens come in each week and producer must decide about the quantity of stock with a comparison or function between the average number and maximum capacity (cap=80 define in the declaration box as the maximum capacity of stock.). This will be done by fun rep(c,cap) In the same time, the order is sent to *Orders* Transition to compare it with the stock. Here, the delivery of goods will be done by the current inventory in the stock and the quantity of remained order, which is not delivered, is stored in *matching* place.

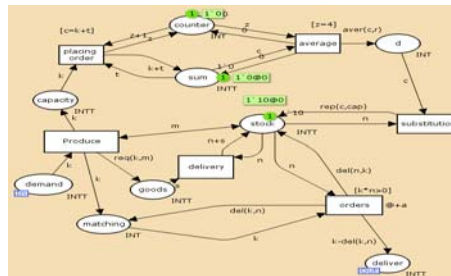


Fig.3 Producer subpages

Each time that goods are delivered to stock by *delivery* transition or periodically by *substitution* transition, the stock will be filled. First of all, we define a token 1'22@+1 in customer order place. This is one order with the quantity of 22 in the first week. If the initial quantity of supplier and producer is 3 and 10 respectively, the output (delivery of goods) is parted and three of requested goods is delivered by supplier in the third week, then the supplier makes his order for the producer with the req(k,n) to replenish its stock and deliver to customer. These deliveries are done every two weeks.

In the next step, we define four orders in the *customer order* to see the performance of dynamic inventory in the producer sub page. The proposed strategy is that the stock of producer and supplier, must be replenished same as the initial quantity that each of them had before. Although, after four weeks if the average demands of customer is changed, it decides to charge or discharge of stock. If the average is less than the maximum capacity of stock it will be replaced with the current stock, otherwise the maximum capacity must be used. Functions 4 and 5 are used for modeling the average function:

fun conv(i)=Real.fromInt((i)); (4)

fun aver(i,j)=round(conv(i)/4.0); (5)

This strategy, demonstrate the dynamicity of organization, which try to adopt with the customer demands. With defining 1'22@+7++ 1'10@+14+++1'35@21++1'8@28 for the customer order (time shows the last day of each week) the result shows that the average of quantity, i.e. 19, is replaced with the current stock and all products are delivered every two weeks. Fig.4, demonstrates the delivery of orders.

## 5. Evaluation

As the number of nodes and arcs is high, calculating full Occurrence Graph is time-consuming. According to Fig.4, a part of the occurrence graph is used, which shows the path of first state to final state. First number in each node shows the node number and the two numbers in the bottom of the node show predecessor and postprocessor nodes. OG ensures integrated operation in which block and deadlock states are impossible to occur.

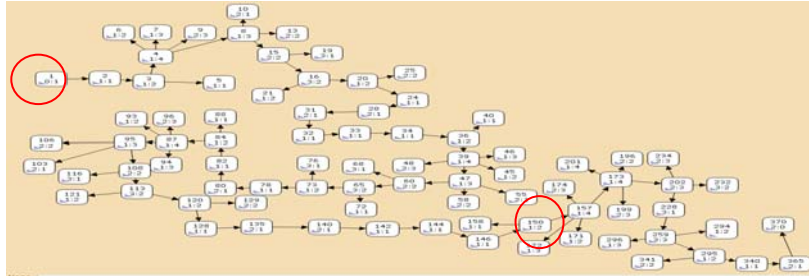


Fig.4 part of Occurrence Graph

## 6. Conclusion

In this paper, social behaviors of collaborative organizations in a chained execution of simple supply chain, and dynamicity are defined. This task follows two policies, if a product in a given period, has the more request than the inventory so the average is calculated for this period, and the inventory is increased. As a result, a result, in the next orders, it can be responsible for more quantity of orders and goods will be delivered to customer in an improved time. While, if the quantity of orders is less than inventory, Producer decides to decrease the inventory in order to prevent decay in products (if they have expiration date). The evaluation is done by an Occurrence graph. It shows all reachable states. Future research directions include the investigation of criteria to improve the inventories which stores multiple goods.

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