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USING CONSENSUS METHODS IN KNOWLEDGE CONFLICTS RESOLVING IN SUPPLY CHAIN MANAGEMENT SUPPORT SYSTEMS

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The paper presents a knowledge conflict resolving in supply chain management systems by using consensus methods. Most often user independently resolves this conflict by analyzing individual variants and taking a decision which of these variants choose. It is time-consumption and process, which is tied with risk of incorrect variant choice. To eliminate these inconveniences it can be use the consensus methods. These methods allow the automatic determine by system one variant, that is presented to the user. Therefore, the knowledge structure, which represents individual variants of solution, was defined in article. This definition is necessary to determine consensus algorithms, which allow to resolving knowledge conflicts supply chain management systems.

Keywords: supply chain management, knowledge structure, knowledge conflicts, consensus methods

1. Introduction

In contemporary economic situation, one of the key fields of operation for companies is the supply chain, since a well-defined and promoted product with lowest prices and superb characteristic will simply not suffice [9]. Low margin as well as consolidation and globalization of the market are all posing a serious threat to a great number of companies, including those on Polish market. Competitive advantage is more and more often becoming subject to efficient orderliness of product supply with minimum expense, as well as proper customer service. That is the reason why many companies are implementing supply chain management strategies. A supply chain is a logistic network composed of suppliers, factories, warehouses, wholesalers, distribution centers, retail outlets as well as resources, production in progress and ready-made goods that are transferred between them [10].

Supply chain management, however, is a series of actions taken for the purpose of effective integration of suppliers, manufacturers, warehouses and stores so that goods is produced and distributed in the right quantities and to the right places, in order to minimize expenses, meeting the needs in the right measure [10].

A contemporary supply chain is characterized by [10]:

- it ability to response quickly and satisfy rapidly changing demand,
- flexibility, the potential to adapt to an optimal cost-to-service level ratio,
- the ability to use company's resources effectively,
- the competence to use all available information.

The reality of rapidly developing market forces companies to search for opportunities to build competitive advantage outside its structure, for individual effort often proves to be insufficient to fully meet customer expectations. In order to meet them halfway, companies are forced to conduct joint operations together with their business partners.

The most important benefit gained in supply chain management is a significant decrease in numbers of inventories, both on the part of the supplier and the customer. The traditional approach assumes supplying in large batches, which is argued by the so-called economic amount of the batch. Additionally, suppliers exercise discounts subject to the amount of a single delivery, which causes further increase in orders. This in turn is the reason for large inventories both on the supplier's part and the customer's. Additionally, it is also the reason for an unbalanced workload on the supplier's production resources and the customer's problems with cash flow [6]. The supply chain should be managed to fit the JIT (just-in-time) model, synchronizing production plans with frequent and relatively small supplies. Such model triggers a number of positive effects, such as a decrease in the number of inventories, more balanced workload of production resources and a decrease in the need for resources, which in turn must be replaced by an increased need for information [8]. Therefore, it is necessary to change production plans, so that it is possible to co-ordinate them and acquire precise information on supplies (orders) and invoices. Many companies use computer systems to gather information and improve communication, both within the company structure and with business partners. Recent years have shown a growing interest among companies in systems aiming at integrating the SCM (Supply Chain Management). The said solutions are used to accurately co-ordinate actions taken by business partners, which is usually achieved through EDI (Electronic Data Interchange). However, professional writings on the subject point out more and more often that the systems should respond to market demands dynamically, thus increasing the value of all companies participating in the supply chain [2]. In other words, SCM systems should operate in real time, which is a difficult matter, considering the computing complexity of algorithms used in these systems and the fact that SCM systems are often based on ERP (Enterprise Resource Planning) [4] data, creating the necessity to integrate flexible analytical applications with rigid data-gathering applications [9]. Therefore, frequently the SCM system presents a number of different alternatives for product transfer between various contractors and the user must make the final decision to choose one of them, having performed proper analysis. It is a time-consuming process, where the user risks selecting the wrong alternative. Such situation is often referred to as conflict of knowledge. However, if the chain management support sys-tem is to facilitate dynamic and efficient management of the supply chain, conflicts of such nature must be solved.

Therefore in this article it is proposed to use consensus methods to resolve knowledge conflicts and, in consequence, automatically determining one of the variants by system. This variant is presented to user and, in consequence SCM system can be more elastic.

2. Knowledge conflicts in supply chain management systems

Conflicts of knowledge in supply chain management support systems result from inconsistency or contradictions in the system's knowledge [5]. If we assume that the sides of a conflict are various alternative solutions generated by the system, then inconsistency occurs when there is a given feature occurring or not occurring within a given period of time in one of the alternatives, but another alternative contains no information on such feature. Contradiction occurs when a given feature occurs within a given period of time in one alternative, but it does not occur in the same period of time in another alternative.

Therefore, conflicts of knowledge occur when the same objects and the same features are given different values by the sides of the conflict. Assuming that the SCM system has generated various alternative solutions (for instance, resulting from using different methods of supply chain management support), for example:

- to transport 5 kg of goods t1 starting at location m1 at 10.00 hours so that the goods reach their destination m2 at 11.00 hours,
- to transport 10 kg of goods t1 starting at location m1 at 9.00 hours so that the goods reach their destination m2 at 11.00 hours,
- to transport 15 kg of goods t1 starting at location m1 at 9.30 hours so that the goods reach their destination m2 at 11.00 hours,

then conflict of knowledge applies both to the feature 'quantity' and the feature 'time'.

The conflict concerns values of features, therefore one may state, it results from contradicting knowledge and its nature is multi-attribute and multi-value.

The paper [3] defines the following sources of conflicts of knowledge:

1. A fight over management of certain resources. A conflict occurs when one side of the conflict thinks that the other side should not possess knowledge of a given resource, while the other side thinks that such knowledge is rightful.

2. Conflict of ideology. It occurs when the sides of the conflict have different beliefs on a certain matter. The said beliefs may result from the type of environment where a system works or from an established course of action.

3. The necessity to integrate different elements or units. If there is a need to integrate a number of system elements into one entirety, a conflict occurs naturally (for instance different structures of knowledge, different ways to present knowledge).

4. Conflicts resulting from operating the knowledge management system. A conflict occurs when neither side of the conflict considers itself responsible for managing knowledge contained in the system.

Supply chain management support systems usually face conflicts stated in 1 and 3.

It is obvious that sources of conflicts of knowledge are vast, that is why many projects have been launched to detect and solve the conflicts. However, the problem of using the method of consensus in solving conflicts of knowledge in supply chain management support systems has never been discussed yet.

However, the concept specified in the article [12] assumes that the SCM system modules that concern suppliers, manufacturers, wholesalers, retailers and individual customers, generate different alternative solutions for each link of the supply chain, based on information provided by transaction systems (e.g. ERP) and analytic systems (e.g. MES, CRM) and employing different criteria or methods of analysis (such as aforementioned: lowest price, shortest delivery time, nonlinear programming, genetic algorithms). The alternative solutions differ in terms of attributes and values for attributes. Therefore, the system faces a conflict of knowledge among those alternatives.

Solving conflicts of such nature is very important, because only then the system can present correct alternatives. If the system ignores this aspect, the user may experience problems with proper management of the supply chain.

The next part of the article will characterize the process of defining algorithms for determining consensus.

3. The process of defining consensus determining algorithm

Essentially, consensus means agreement [7]. If the SCM system generates up to a dozen alternative solutions, based different criteria or methods of analysis, then using the consensus method will help determine one alternative which will be presented to the user after-wards. The alternative does not have to be an SCM-generated solution. It may be a totally new alternative created on the basis of existing alternatives (SCM-generated) [11]. Because of this, all SCM-generated alternatives can be considered. Such course of action allows, among other things, to shorten the time necessary to determine the final solution (the user does not have to analyze each alternative and make their selection – the system will do it for them) and to decrease the threat of selecting the worst alternative solution (since all alternatives are considered in the consensus method). Consequently, the supply chain management process can be performed faster and more effectively.

What needs to be emphasized again at this point, until today the consensus theory has not been used to support supply chain management. Let us note, however, that the results obtained from using the consensus method are a good representation of a given set of SCM-generated alternatives, because they take into consideration literally all the alternatives, while the methods of selection (one alternative is selected among all alternatives generated by the system) consider only one alternative in large measure, while other alternatives are considered in small measure.

The process of determining consensus is composed of three basic phases:

1. The First Phase includes thorough examination of the structure of the set with all SCM-generated alternatives to determine the features that represent those alternatives and the fields of their values. The structure is the arrangement of the components and the relations between and among them, specific for a given system as a whole. In other words, it is a set of features of a given alternative [1]. The structures of these alternatives compose the structure of knowledge in the SCM system.

2. In the Second Phase it is essential to define the function to compute the distance between the alternatives.

3. The Third Phase includes designing algorithms to determine consensus, meaning an alternative that is located at minimum distance from all the other SCM-generated alternatives (according to different criteria).

This article pays special attention to the first Phase of determining consensus, as only formal determination of the structure of knowledge in the SCM system will allow to continue work at both stages that follow. Therefore, let it proceeds to the formal definition of the structure of alternative, being the structure of knowledge in the SCM system.

Definition

Following sets are given:

set of products $T = \{t_1, t_2, \ldots, t_N\}$, (1)

set of places $M = \{m_1, m_2, \ldots, m_L\}$. (2)

The structure of variants is called following sequence:

$$W=\{\langle t_1,m_p,m_q,dt_{m_p},dt_{m_q},i_1,k_1\rangle,\langle t_2,m_r,m_s,dt_{m_r},dt_{m_s},i_2,k_2\rangle,\ldots$$
$$\ldots,\langle t_N,m_x,m_y,dt_{m_x},dt_{m_y},i_N,k_N\rangle\} \quad (3)$$

where:

$p,q,r,s,x,y=\{1..L\}$,

$dt_{m_p}, dt_{m_r},..., dt_{m_x}$ - date and time of come out the places $m_p, m_r,..., m_x$ by products $t_1,t_2,...,t_n$,

$dt_{m_q}, dt_{m_s},..., dt_{m_y}$ - date and time of come in the products $t_1,t_2,...,t_n$ to places $m_q, m_s,..., m_y$,

$i_1,i_2,...,i_N$ - number of transport products $t_1,t_2,...,t_n$,

$k_1,k_2,...,k_N$ - cost of transports products $t_1,t_2,...,t_n$.

If it is assume that:

$T=\{product1, product2\}$, $M=\{enterpr1, enterpr2, enterpr3\}$,

then an example of structure of variants can be following sequence:

$$W=\{\langle product1, enterpr1, enterpr2, 2012-08-01\ 10.00, 2012-08-01\ 15.00, 10, 100.00\rangle,$$
$$\langle product2, product3, product2, 2012-08-01\ 11.00, 2012-08-01\ 15.00, 3, k50.00\rangle\}$$

In this example product1 in number 10 must come outenterprise1 the first of august 2012 at 10.00 hour and come in to enterprise2 at the same day at 15.00 hour, cost of a transport is 100, instead product2 in number 3 must come out enterprise3 the first of august 2012 at 11.00 hour and come in to enterprise2 the same day at 15.00 hour, cost of transport is 50.

Elaborated definition enable to present particular variants of solution at uniform structure. It is complex, multiattribute structure. It is appears different types of data at this structure.

If the variants structures generated by SCM are different or values of attribs of these structure are different then at the system a knowledge conflicts appears. It is necessary to go to second and next to third phase of consensus determining.

4. Conclusion

Employing the consensus methods to solve conflicts of knowledge in supply chain management support systems enables to use the results from a number of alternatives for supply chain management at the same time, so it is time-saving, because the system user does not need to wonder which alternative to select. It also avoids analysis of each alternative, per-formed by the user. Consensus is a solution that considers all alternatives generated by SCM system modules and uses them as basis for determining an alternative that will be presented to the user. In other words, each alternative contributes to the consensus. Consequently, this allows to effectively integrate all elements of the supply chain as well as per-form proper risk management in this field. Since the system automatically generates the final version of the alternative solution using the consensus method, which shortens the time for selecting the right alternative considerably, it is possible for the system to operate in near-real time. It is also noteworthy that the use of the consensus method enables to generate a satisfactory alternative for the user. Since the decision made by the system is utilizable to some extent for the user, it becomes possible to 'raise the bar' so that the decision becomes more and more utilizable. Because of this, supply chain management may become more dynamic, which obviously influences the operational effectiveness of each unit as well as the entire supply chain.

The structure of knowledge (alternative) defined in this article will allow to conduct further research in the field, which includes defining the function to compute the distance between the structures, devising formal algorithms to determine consensus, and creating a module that determines consensus in the SCM system.

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