Business process modeling for flexible tasks workflow

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Abstract. Implementing new solutions in the production hall and offices, companies are looking for solutions that will support the execution of production orders and increase their competitiveness. These changes are caused by new technologies and opportunities by industrial development. These possibilities give a set of solutions that were unknown or impossible to implement in the past. As enterprises develop, they should point on aspect of decision support systems and business process modelling out to. Due to new technologies and IT development, appropriate management of the production processes and business is required. In the article focused on modelling business processes in enterprises. An algorithm for making decisions support in enterprise was also presented.

1. Introduction
Small and medium-sized enterprises often look for solutions to find themselves in a competitive environment [1, 2]. One of the concepts is cooperation with other enterprises through a virtual manufacturing network. The other is the cooperation by an outer server [3, 4]. Due to cooperating in a network, manufacturers share their available production resources. However, next to the choice of production process routes, there are problems to, for example with creating the virtual network, share tasks between manufacturers or model business flow between manufacturers or collect information and data in such a flexible environment.

In the article the algorithm of join to the virtual network from the manufacturer point of view is showed. And a diagram of business process flow in the network through BPMN notation is also showed.

2. Virtual Manufacturing Network
Virtual manufacturing network is create by a single enterprises, which are geographically dispersed. These companies temporarily cooperate with each other for purposes - make a production order. The base in this concept is use the available production resources, skills and knowledge of each manufacturer, cooperating in the network. This solution allows manufacturers to carry out a production order, without any disruptions to their existing production plan. The size of the network is determined by the number of manufacturers, who cooperate at production order. Meanwhile, the individual tasks assigned by the integrator and the time for transporting components between manufacturers must be also included. This is due to the geographical dispersion. Additionally, due to shared and concurrent production, the order of tasks and operations is also important [5, 6]. All operations must comply with the specifications of the technology documentation. Included the production resources of each manufacturer, the production process routes are created. In this type of cooperation, the problem is a big set of data that needs to be properly stored and then analyzed [7,
8]. Additionally, the problem is also dynamism in network, related to the variable number of manufacturers in the network. This dynamics cause that not only production information are important, but also business processes, their flow and flexible connections between manufacturers. It causes, that new concepts, that will support both, business processes, planning and task allocation are needed. The aim of this solution is to facilitate the flow and analysis of the data, on which relevant decisions in this concrete situation are made.

Figure 1 is presented a general scheme of basic information of a single enterprise, which is planning to join to the virtual manufacturing network. This is the basic data, that are required for the initial stages of network creation. These data are properly collected and stored, so an authorized person, e.g. an integrator, could interpret them properly. Nowadays, one of the most popular data collection methods is the so-called cloud. The appropriate collecting of data is important for makes decisions about creating a network by the integrator. This information is equally important to, because on these, the tasks are accordingly assigned to each manufacturer.

Because of the fact, that the virtual manufacturing network is create of individual manufacturers, which carry out a specific production order, appropriate data is required, to allow for realization of tasks. Knowing the details of the production order, integrator creates a virtual manufacturing network, under the assumption, that manufacturers fulfill the requirements. Figure 2 is showed a virtual manufacturing network, in which the four manufacturers is cooperating. Each of them has a set of available production resources. The distances between producers are also known. This information is collected and stored in the cloud. Because of them, the production tasks and routes are determined. An integrator based on available data, decides for example about realization of tasks, and selection of producers.

Figure 1. Basic information of single manufacturer needed to create of virtual manufacturing network.
However, in addition to the development of routes and selection of manufacturers to the network, there is a problem with the flow of business processes in such a flexible environment as virtual manufacturing networks.

3. **Joining to the virtual manufacturing network**

Virtual manufacturing network is characterized by continuous and dynamical changes, relating to both the number of manufacturers in the network and the different fields of activity each of manufacturers in the network. In the first step, a general algorithm for a decision-making situation, about the participation of a single manufacturer in the network is showed (figure 3).
Start → New production order → Would the manufacturer like to cooperate in a virtual manufacturing network?

- No → Stop
- Yes → Does the manufacturer have available production resources?

- No → Stop
- Yes → Prepare list for machines and equipment of each manufacturer → Prepare due date for available production resources → Determine possible variants for production routes → Prepare transport between manufacturers → Create virtual manufacturing network → Selection of an integrator → Signature of required documents → Stop

Are there other manufacturers with available production resources?

- Yes → Prepare list for machines and equipment of each manufacturer → Prepare due date for available production resources → Determine possible variants for production routes → Prepare transport between manufacturers → Create virtual manufacturing network → Selection of an integrator → Signature of required documents → Stop

- No → Stop

Figure 3. Algorithm of decision making situation by each of manufacturers.
The above algorithm shows the creation of a virtual manufacturing network from a point of manufacturer. This solution requires many decisions, which sometimes have to be made quickly. In the meantime, when manufacturers prepare the required data, an integrator is selected, who is responsible for functionality of the network. His job is to prepare the documents, required to realize the tasks to. However, if it is not possible to determine the set of routes or create the network, the process of searching for manufacturers with available production resources must be repeated. Steps showed in the algorithm also require an appropriate flow of information. Without this, the implementation of tasks in the network would be limited. All data and information is collected by the integrator. However, manufacturers also have access to some of the data (related to their enterprises) in order to modify them at any time. That is why, the database with access for everyone, e.g. the cloud is important, but proper protection the cloud, against data theft is important too. Taking into account the implementation of variable tasks and steps for manufacturers, it is also reasonable to use graphical notations of business processes flow (BPMN).

4. Notation of BPMN
Considering business processes, the concept of Business Process Management should be taken (BPM). This is a set of various methods, techniques and tools for creating and analyzing business processes, using the organization's resources, including human resources, applications, documents and other information. Business Process Management includes three phases: business processes modeling, business process execution and business process monitoring [9, 10]. Whereas Business Process Model and Notation (BPMN) is a standard developed by Stephena A. White. This notation is designed to show the flow of process and information between processes [11].

In the article, due to the complexity of making decisions and many tasks realized at the same time in virtual manufacturing network, an example of BPMN is showed (figure 4).

BPMN is used to describe tasks, which are realized on the integrator-manufacturer level. And also, as well as inside the single enterprise, when the steps to join to the virtual manufacturing network are taken. If the requirements from the integrator are not fulfilled, enterprises decides to resign from further activities in this concrete virtual manufacturing network. By the notation can be written down an enterprises available production resources and a schedule of their availability. This is a very important step from an integrator's point of view, because on the basis of this data, he decides about cooperate with enterprise at a specified production order. But also, the review of the required...
documentation is also an important step. Without this, the manufacturer does not fulfill these tasks properly.

This approach also allows widening the system with the possibility of cooperation with control system and signals detection [12,13] and even link the control signal detection with material attributes analyzing [14].

5. Conclusions
The implementation of new solutions, involves many tasks and decisions to realize. Small and medium-sized enterprises are looking for solutions that will help them to be competitive. One of the idea is a virtual manufacturing network. This solution allow to sharing tasks between manufacturers or model business flow between manufacturers. Also, it is possible to collect information and data using this approach. Generally this allow to operating without disruption in complex cooperating systems.

However, the emerging problems are: the separation of tasks in the enterprise and the flow of business processes in such a variability networks. In the article the general algorithm of join to the virtual manufacturing network from the manufacturer's point of view is presented. A diagram of the flow of business processes in the network by notation BPMN is also presented. By writing actions using BPMN notation, manufacturers can identify, what tasks are needed to be completed, while creating a virtual manufacturing network.

6. References
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