Abstract

In this paper were considered the ways of describing supply chains by quantity modelling for modern companies. The focus is on existing software products to account external and internal flows of processes. The most appropriate tools were considered for achieving resilience of supply chain. The examples of finished work of these software products are given as illustrations.

Keywords: supply chains, resilience, simulation, software.

1. INTRODUCTION

Modern computer technologies are used to monitor and correct distribution of resources in the logistic companies. Analytical, statistical, simulation and heuristic methods are used as tools to solving problems of supply chain management. Logistic models can also be separated into quantitative and qualitative types. Accordingly, the difference between these models is in the form of information providing in numerical and visual styles. This paper is devoted to the modelling of quantitative simulation models. Quantitative models calculate numerical estimates of indicators for the supply chain. Decisions are made on the basis of their network configuration, distribution and productivity of resources and operational management strategies.

Simulation methods are studying the behavior of the model object by creating of experimental model [1]. This modeling is used for finished supply chains, but can't help in creating and designing. Their use is most appropriate in cases of high complexity and dynamics of the system being modeled.

Regularities of the system behavior are identified by different input data based on the determination of the numerical parameters. Combined application of the methods of optimization and simulation based on multi-agent systems is the most effective. The theory of system dynamics relates to methods of simulation of supply chains based on nonlinear dynamical systems [1]. Most of the quantitative indicators of the system are estimated in the form of dynamic time series with discrete events. Finished simulation model is a computer program that implements numerical solution methods for the tasks of a real object.

2. PRACTICE

In the contemporary world simulation models of logistics systems are occupied by a steady place in the market of software products (AnyLogic, Arena, AutoMod, eM-Plant, Enterprise Dynamics, Extend, GPSS, ProModel, QUEST, Simul8, WITNESS, etc.).

The individual approach is organized at the creation stage of simulation models for each company, because you need to take into account the specifics of the processes within the system and the structure. The manager defines the basic parameters of the system, which include:

- input and output flows;
- transport channels for describing of the system spatial structure;
• organization and cost of cargo transportation, selection of equipment, loading rules, routes and points of shipment of the goods;
• the location of places for intermediate storage of goods;
• business transparency and standard supply chain management strategies;

Significant positive effect is observed in the implementation of the enterprise simulations. Such models are used especially well for simulation of the functioning of the supply chain under different management strategies and in optimization of dynamic processes.

3. SOFTWARE FOR BUILDING RESILIENCE SUPPLY CHAINS

A large number of existing software products adapted to the specific supply chains. The most appropriate software products were described in this paper for convenient analyzes and improves resilience supply chains. The modular structure is used to implement the programs, because it allows you to make changes in the program without a significant change in parameters.

3.1 DOSIMIS-3

Transport logistics systems can be analyzed using the tool DOSIMIS-3. The structure of the programming environment developed on the basis of modules and objects. Parts of the supply chain are implemented as elements of a work environment that replicate actions of real objects with the required accuracy. The underlying object-oriented philosophy of modeling assumes that buffers and conveyor belts, work stations, reject gates will be represented by modules, which reproduce the behavior of this elements within the required accuracy. The workspace of the software is shown on Fig. 1. A model is created in several steps:

- place modules;
- edit module parameters;
- connect the modules;
- define parameters of simulation;
- run the simulation;
- see the result statistics.

This approach allows the analysis of causes of congestions, interruptions of material flows, thus preventing adverse effects, which influence on effectiveness of the company. The tool makes it possible to analyze the
system in which the material is transported or waiting for transportation. The implemented model can help to research in the order of the transport optimization and system management, which cooperates with subsystems of the production.

Inputs and outputs must be selected such information, which are critical for the loading and delivery of materials from the devices. Besides data entry allows you to develop a process model in detail on the basis of a minimum number of items needed to achieve project objectives.

In the article [7] was described the model of production system in metallurgical plant by DOSIMIS-3. This model solved control problems of unit flow. Optimization problems and using of production equipment and transport have been resolved, and the time demands and costs of production have been identified. The basic elements used in the model included the objects of the information system, performance, range, orders, costs, production time of transition to a different type of product. The following topics were analyzed to optimize the simulation system:

- time of the rolling;
- effects of transport equipment;
- using transport items in production;
- duration of the process.

3.2 AnyLogic

The next described software product for modelling of resilience supply chains is AnyLogic. In the source [1] the model of adaptation control in supply chains were described. The model shows supply chain, which consists of several producers with unlimited sources of raw materials and consumer. Producer controls the amount of product with inventory in the warehouse, if the finished products in stock less then finished goods threshold. At the other side manufacturer orders row materials by another supplier, when the volume of row materials in warehouse is falling less than ordering threshold. Customer buys the product with ordering rate. Participants of the simulation choose from a several variants and use transparent history of previous orders with actual information about parameters state. Producer chooses the most optimal solution from the customer point of view.

![Fig. 2 Search of bottlenecks in AnyLogic](image)

The purpose of modelling was to determine the changes in the structure of the supply chain when the parameters of production (finished good threshold, ordering threshold) and external parameters (ordering rate) was changed. The volume of finished goods threshold, ordering threshold and ordering rate of a
customer changed during the simulation [1]. As the result of parameter changes, the structure of supply chain was also changed. States of model items was changed by animation engine.

Regulation of the system was performed by relevant structural and functional changes in management and planning in the case of adverse predictions or large deviations in the operation of the supply chain. The proposed model allows the manager to get an integrated view of the dynamics of orders and serves as the basis for making operational decisions.

4. CONCLUSION

This article provides an analysis of the existing solutions to achieve sustainability of supply chains. Among those software products were selected the most suitable for different supply chain and describes how they apply in practice. Further research is directed to building the model of supply chain in described software for automotive industry. Complexity of the model will affect the choice of software.

ACKNOWLEDGEMENT

This contribution came from the Czech Ministry of Education, Youth and Sports support of the grant project No. SP2013/49.

LITERATURE


