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SIMULATION METHOD FOR DESIGN AND ANALYSIS OF LOGISTICAL PROCESSES

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Abstract: There are lot of tools and sophisticated methods for design, analysis and improvement of logistical processes. The author introduces the most often applied method for it, which is the simulation. The paper summarizes the typical application fields of simulation and the reasons for application of it. Main aims of logistics process improvement and the main steps of a simulation process are also detailed. Finally the advantages and disadvantages of simulation method are introduced.
***Keywords**: process improvement, simulation method, steps of simulation process*

1. INTRODUCTION

The world around us is a very complex and multi-parametric system, like the weather, traffic, operation of machines, production processes etc. Understanding of the characteristics, operation and behavior of these systems and processes is not easy due to their complexity.

The design of optimal production procedures is an essential task for planners.

The target is the increasing of the efficiency of the production and analysis of the effect of parameter changing. There are lot of tools and sophisticated methods for design, analysis and improvement of logistical processes. The most offen used analysis tool is the simulation.

2. MAIN AIMS OF LOGISTICAL PROCESS IMPROVEMENT

The production and logistic goals are originated from general corporate goals, of which maximal customer satisfaction is one of the most important. Actually all the other goals can be derived from this, which are listed in the following paragraph (logistic goals are underlined).

With shorter lead time the customer would get the ordered product in the shortest time possible. Economical and profitable corporate operation can be achieved by utilizing the maximal production (or service) and logistic capacities, which includes the optimal utilization of human sources and equipments. Flexible production (or service) and logistic is needed to answer the demands of the rapidly changing economics and dynamic customer demands. The development of business processes can by realized only by high transparency and by the continuous monitoring of the efficiency of the systems, since which process can be measured is can be improved.

Ensuring and enhancing the quality of the processes is of priority for customer complacence. Nowadays sustainability and the use of environmental-friendly materials and technologies are also defined as a goal, as well as green waste management and recycling. In terms of cost reduction the main goal is to decrease stocks and to operate production and service processes efficiently throughout the whole supply chain and at each individual party in the supply chain.

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3. SIMULATION METHOD FOR ANALYSIS OF LOGISTICAL PROCESSES

Analysis of complex systems can be carried outby the application of models. A model is a simplified representation of a complex real-world system and process in a mathematical system.

More and more information can be gained about the characteristics, operation and behaviors of a real system or process by analyzing and studying a model.

The simulation model "simulates" the analyzed complex system, in order to imitate its real behavior. The model is able to take into consideration only the most important elements of the complex real-world system, so it is a little bit simpler compared to the real system. This simplification makes it possible to examine complex systems.

Simulation is an analysis tool for the imitation of existing or non-existing systems by the help of a model. The behavior of the real system can be understood by the examination of the model. It is the most widely used tool for decision making [1–4].

VDI (Verein Deutscher Ingenieure, Association of German Engineers) Guideline 3633 [5] defines simulation as the emulation of a system, including its dynamic processes, in a model one can experiment with. It aims at achieving results that can be transferred to a real world installation. In addition, simulation defines the preparation, execution and evaluation of carefully directed experiments within a simulation model [6].

3.1. Application fields of simulation.

Typical application fields of simulation are the followings:

- design and analysis of production systems,
- optimization of supply chains,
- design and analysis of traffic systems,
- analysis of military processes,
- examination of structures and structural elements etc.

The most common application field of simulation software is the analysis of production processes. This is because of the following tendencies:

- production activities are very complex stochastic processes,
- customer demands are changing extremely fast, which results in
  - changing of production volume,
  - changing of product variety, or
  - modification of the production process,
- the pressure of continuous cost reduction and efficiency improvement requires optimization and improvement of production activities.

Simulation can be applied, for example, when we have to plan a new facility, or optimize an existing facility.

3.2. Reasons for application of simulation software.

Simulation analysis of production processes is required in case of:

- deterministic processes of complex and big systems and processes;
- stochastic processes of systems and processes in which influencing events occur randomly [7].

Random events can be, for example:

- operational problems of machines,
- breakdown of material flow machines,
- lack of equipment- or human resources,
- lack of component supply (supplier or transport problems),
- defects of control systems etc.

Aims of simulation in the analysis of production or logistical processes:

- elimination of mistakes during the design of new complex production systems or material flow systems,
- comparisons of system variations,
- analysis of deterministic and stochastic processes,
- providing the possibility of bottleneck analysis,
- optimization of parameters of machines, processes and systems to increase efficiency,
- comparison of operation strategies,
- simulation of occurrence and elimination of abnormal system operation,
- examination of system parameters and influencing parameters etc.

4. MAIN STEPS OF A SIMULATION PROCESS

The main steps of a simulation process are the followings *(Figure 1):*

- Step 1: Preparation of the simulation analysis
- Step 2: Run simulation
- Step 3: Evaluation of results
- Step 4: Making suggestions

4.1. Preparation of the simulation analysis.

The first step of the simulation process contains different tasks, which are

- identification and formulation of problems, determination of objectives of the simulation analysis,
- process analysis, determination of parameters to be examined,
- determination of input data required for simulation, collection of real system data,
- formulation and development of a model,
- working out operation algorithms.

The first task of preparation of the simulation analysis is the identification and formulation of problems. After this, the objectives of the simulation analysis and the Key Process Indicators (KPI) to be improved should be determined.

The most frequently used KPIs are:

- reduction of lead times,
- reduction of machine set-up times,
- reduction of stock,
- optimization of production areas,
- improvement of product quality,
- improvement of productivity.

Analysts have to define the parameters to be examined and their influencing factors should also be determined. During the process analysis the relation and functionality degree of parameters need to be examined and influencing factors should be determined.

The reliability of simulation results depends on the accuracy and reliability of data collected from the real-world system (e.g. production cycle times, volume of stock, distance of machines etc.) [8]. These data are the input data required for the simulation.

The next task is the formulation and development of a model that is appropriate to simulate the complex real process to be examined. The simulation model includes simplifications compared to the real process in order to manage the complexity of the real system.

Finally model testing and validation will be completed or, if required, the original model will be modified.

Operation algorithms of the production system should be elaborated and the appropriate subroutines should be developed.

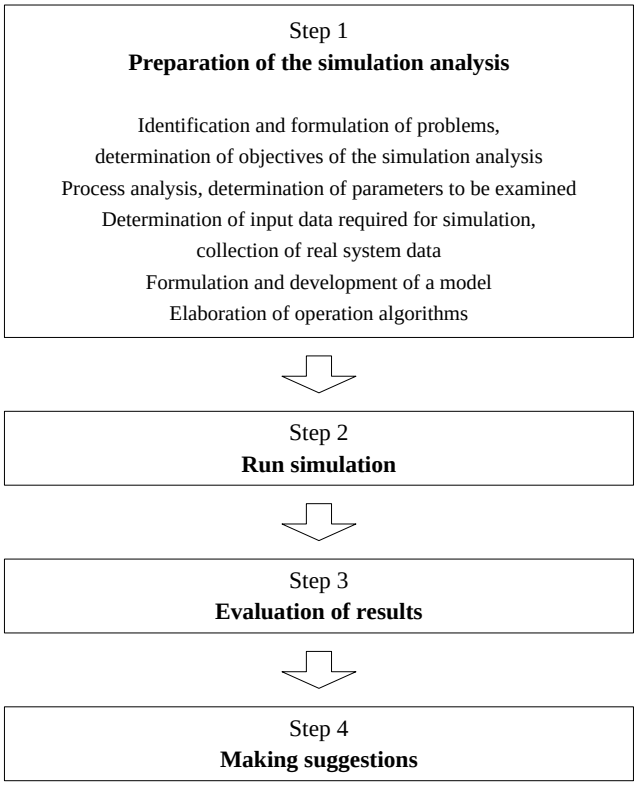

Figure 1. Steps of a simulation process

4.2. Run simulation.

The simulation run should be performed – several times, if required – by the application of different operation strategies, or different input data or system parameters. Results of the simulation run are the output data.

4.3. Evaluation of results.

Results of simulation runs should be evaluated and analyzed. The conclusions drawn after the evaluation will be used for forming suggestions.

4.4. Making suggestions.

Required system modifications should be defined based on the results of simulation runs in order to improve the values of selected key process indicators. Suggestions for real system modification should be formulated in the form of action plans. These plans should be implemented in the real system to achieve the improvement goals.

5. ADVANTAGES AND DISADVANTAGES OF USING SIMULATION

There are lot of tools and methods for design, analysis and improvement processes, but the simulation is the most common method for design, analysis and optimization of logistics systems.

Besides advantageous properties of the simulation, there are some disadvantages which result limit for application of it. Application of simulation softwares has many advantages and disadvantages which are the followings.

Advantages of simulation:

- Simulation can help to understand how the complex real-world processes operate.
- Simulation is the only appropriate investigation tool when traditional mathematical analysis methods are not available.
- It offers a good solution for examining complex systems and processes.
- The effects of modifying system parameters can be tested virtually, without disruption of a real ongoing process, so costs can be lowered or the chances of system failure can be reduced.
- The modification of an existing model or its parameters is easy, and a lot of newer model or system variations or operation strategies can be tested.
- Time can be compressed or expanded to allow for a speed-up or slow-down of the phenomenon, and long and short-term effects can be predicted.
- Bottleneck analyses can be performed.
- The examined system operation can be visualized with animated simulation.

Disadvantages of simulation:

- The usage of simulation software requires special expertise and competences.
- It is often expensive and time consuming to develop a simulation model.
- The simulation model includes simplifications of the real process in order to manage the complexity of the real system.
- An invalid model may result in incorrect results and conclusions.

6. CONCLUSION

Simulation is a very often used method for logistical process design and improvement.

The author described the typical application fields of simulation. Main aims of logistics process improvement and the main steps of a simulation process were detailed. Finally the advantages and disadvantages of simulation method were introduced.

Simulation is a widely used tool for design and analysis of logistical systems and processes.

This method offers a good solution for examining very complex systems and processes, bottleneck analyses, evaluation of different scenarios and very efficient visualization of animated simulation.

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