# RATIONAL MAKING DECISIONS IN BUSINESS PROCESSES WITH UTILIZATION OF THE MODELLING AND SIMULATION METHOD

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***Abstract**: There is presented the analyse of production processes with utilization of the modelling and simulation method, in the paper. There are determined the rules of creating models of the production process run in the production systems at mega-processes level – activity chains which are connected for example with material or information flow. Then there are presented the rules of the modelling and simulation production subsystems - manufacturing departments, supply and sale. There are described examples of different decision situations from production practice.*
***Keywords:** modelling and simulation, production process*

## 1. INTRODUCTION

Computer technologies are the basic tool of accumulation and exchange of information in contemporary enterprises. Methods of artificial intelligence and expert systems are more and more commonly used in management processes. People who manage the realized tasks in the enterprise often ask themselves two questions: *„Why?”* and *„What will happen, when?”*, wanting to make the tasks as good as possible, that means quickly, with lower costs and more effective [1,2,3].

Realization efficiency of the production process depends on many factors. The most important are the enterprises organizational structure and the process run structure.

Using of present tools of analyses, inferences and projecting is helpful in rationalization of processes. There often are used such instruments as:

- benchmarking,
- methods of time resources management,
- methods of calculation and forecasting of process' costs,
- modelling and simulation,
- expert systems.

The model based on the macro run of the production processes includes all the processes performed in the company. Except of the transformation processes of inputs e.g. of materials

or information in the inputs that is the products or services, this model also takes the management processes into consideration, that is the processes of initiating, organizing, motivating and controlling and the processes of supplementation and development of the personnel, finances, information and material means. The production processes can often be realized in a different way, that means there is the possibility to design several variants of the production processes run. Modelling and simulation gives the possibility to check these variants and makes it easier to choose the best one, according to the assumed criterions.

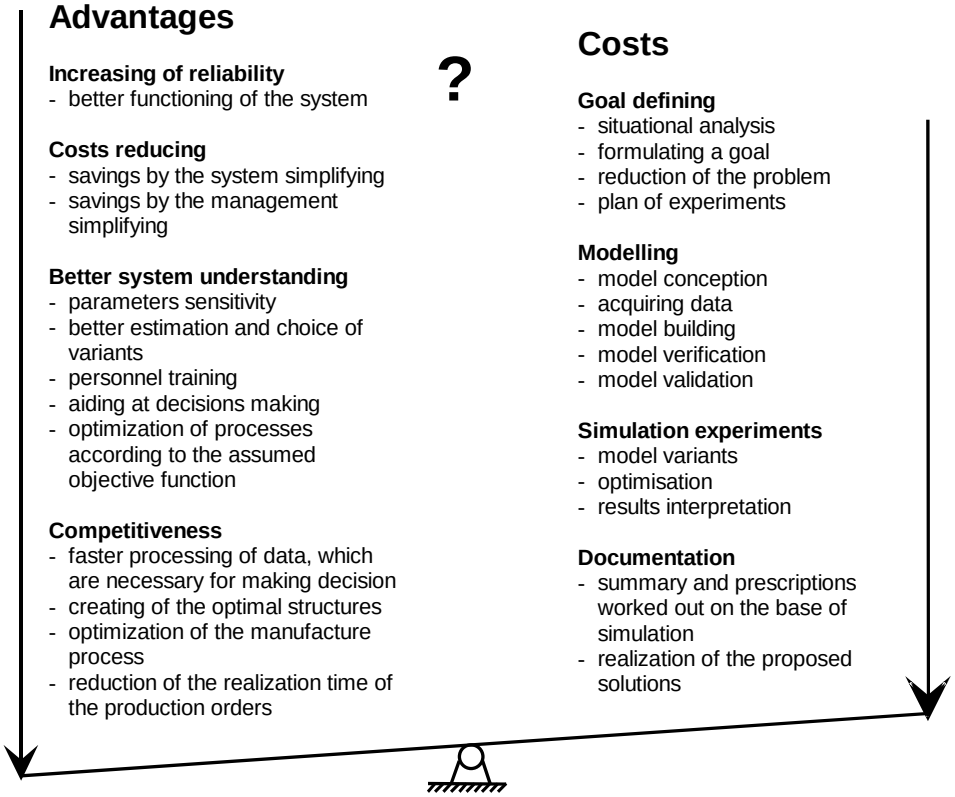


Fig.1. Advantages contra costs in the modelling and simulation method [2]

The universal procedure used in methods of modelling and simulation, includes the following main stages [2]:

- problem's determination,
- model's building,
- preparation of input data,
- realisation of experiments on the model through implementing of different input data and observation of the model's behaviour,
- verification and modification,
- analysis of simulation results,
- working out the activity programme.

## 2. RULES OF EFFECTIVE MODELLING AND SIMULATION

Using the tools for modelling and simulation one should take into account the following rules:

a) Profits obtained by the use of modelling and simulation have to be bigger than the expenditures, which are necessary for realisation of simulation and for improvement of the production system. The main criterion, at undertaking the decision about the utilisation of simulation in practice, are the benefits resulting from its utilization. These advantages can be divided into quantitative and qualitative ones. In many cases, a target of modelling and simulation is not to achieve a precise economic result, but e.g. to improve the functionality, effectiveness, or reliability of the system run – [1, 2].

b) To get the best effect from the simulation, it must be conducted in the right time, i.e. at initial phase of working out the project because then, at the beginning, it is possible to determine suitable parameters of the system being designed. Additionally, the costs of realisation of changes proposed on the basis of conducted simulation, at the beginning of project realisation, are the lowest. Later, it is more difficult to introduce changes and also additional costs, which exceed expected profits, appear (Fig.2.) – [1, 2].

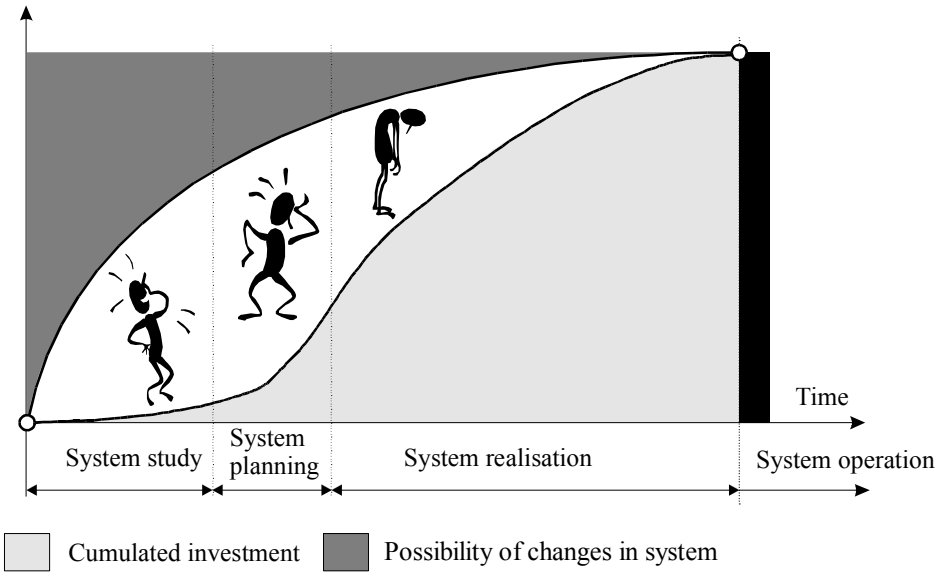


Fig.2. Possibilities of changes and costs of investment at different stages of project's realisation [1]

c) System for modelling and simulation of the production processes should be integrated with information system of the company. Company's databases should be a direct source of data for simulation. In the modelled production system one can easily and quickly change the production plan, check both different variants of production schedules and possibilities of realisation of different production orders [2, 5].

## 3. ANALYSIS OF THE PRODUCTION PROCESS RUN

Efficient analysis of the production system functioning requires fulfilment of two conditions:

- collecting and disposing of information about the realized production process,
- disposal of theory and technique assuring the obtainment of an optimum state.

At the beginning of any analyses there is necessary to define the input parameters of the analysed system, which would collect, and output parameters, which will be a result of the conducted analyses on the base of which, there will be accomplished an opinion about the analysed system. There can occur two cases. First, in which for the made assumptions of the input parameters there will be conducted a simulation of the system maintenance. Second one, in which different collections of output data exist, where problem of finding of the optimum to produce articles with the best parameters from the point of view of the criteria of opinion exists. It is difficult to find the optimum solution. Proper planning of particular stages of experimental researches, finding possible variants of solutions and, first of all proper settlement of criterions of opinion are necessary.

In case when while modelling and simulation many variants of proposed solutions, researches of all possible combinations come into being, all possible arrangements of value of the studied factors are very time-consuming. If it is not possible to examine all arrangements, there should be studied only these variants, which are chosen on the base of subjective opinion of the researcher, his intuition and knowledge about the object of researches.

By the modelling and simulation method we can realize various analyses of functioning of the whole or selected parts of the production system. For example, it can be:

- Analysis of orders' realization – on the model of the whole factory;
- Analysis of planned investments;
- Analysis of costs;
- Analysis of employment;
- Analysis of different systems of production control;
- Analysis of the influence of grouping of the manufactured parts on the time of orders' realization;
- Analysis of the influence of working sequence of different parts on the time of orders' realization;
- Analysis of workplaces buffers;
- Analysis of change of workplaces settings according to the workers' skills – multiprofessionalism and multi-machine operations; ...etc.

## 4. AN EXAMPLE OF MODELLING AND SIMULATION OF THE PRODUCTION PROCESS RUN

In the analysed system there is produced office furniture: the two-partial office wardrobe with shifted doors and the desk with a cabinet on castors [4].
The necessary materials for producing of mentioned articles were divided into three groups: elements of wardrobes, desks and common ones. These materials are ordered together without defining theirs destination.
At the end of manufacturing stage we get installed and packed furniture, which is sent directly to shops and wholesalers. The aim of the realized analyses was the test of present system functioning and testing different possibilities of development.

There were made the following assumptions:

- times of realization of production operations were determined,
- the planned size of production was determined,
- the demand of particular materials was defined,
- distances between suppliers and the firm were specified as well as the distance between firm and recipients (wholesalers and shops),
- the way of transport, times of transport and the unit cost (per km),
- potential firms were situated, with which would be cooperated (preparation of materials and assembly),
- parameters of simulation were defined (time of cycle e.g. week or month and quantity of cycles).

The production process was analysed on the first stage. Different programmes of production were compared. The duty of available resources analyse was done and on the base of test data the calculation of costs was accomplished. For different variants of possible changes, material and workplaces costs were compared.
For example in next simulation models chosen operations (cutting of panels, assembly) were realized in cooperation, as a result there was achieved shorter time of production process realization.
In the next stage there were analysed supply and sale processes taking earlier proposed changes into account. In table 1 there is introduced the description of the following variants of simulation models.

Table 1. Variants of simulation models

| Variant | Descriptions |
|---|---|
| 1 | The whole process is realized in the firm - all materials are compiled and processed in the company. Assembled wardrobes and desks are sent to wholesaler and shops. |
| 2 | Furniture panels and fibreboards will be bought after cutting them into suitable dimensions, directly from the supplier. |
| 3 | Cooperation was made with the company which veneers edges of furniture' panels. |
| 4 | Workplaces of assembly were liquidated and prepared elements were assembled directly at customers. |
| 5 | Cooperation was made with the company which assemblies desks and wardrobes. |
| 6 | The production process was improved – increase of production efficiency was accepted at about 10% level for checking the possibility of distribution net of finished articles. |

It is possible to create next variants of the analysed production system comparing and estimating the results from the conducted simulation.

Results from the simulation made comparing different variants of proposed changes in the analysed production system possible. They were compared from point of view of times and costs of orders' realization. The best results were achieved in variant 6. The possessed production resources make possible production increasing at about 10% without any necessity of additional financial expenditures. However, it is necessary to execute some part of works in cooperation (cutting and veneering of panels and furniture assembly).

On fig.3 there is introduced the variant of simulation model with two cooperating firms: the firm which cuts and veneers panels and the firm which assemblies parts compiled in our firm. This simulation model was worked out in ARENA.

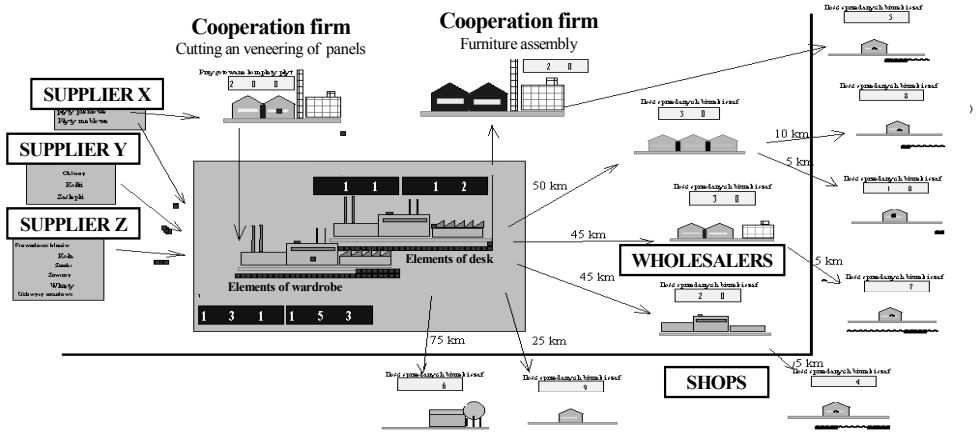


Fig.3. Simulation model

Thanks to the simulation:

- there were checked production abilities of the present system,
- there was estimated the influence of proposed changes on production ability of the company, costs of materials, manufacturing, transportation and cooperation,
- there were compared different directions of the company development in area of the supply and sale,
- there was created the simulation model, which can be used to manage production process (for testing possibilities of different production orders realization).

## 5. CONCLUSIONS

The modelling and simulation is an universal technique, what inflicts, that it finds more and more wider use in enterprises. It is more and more important aiding technique for designing of new production systems aiding production management as well. It makes tracing the production functioning and detection of weak points possible. It enables tracing effects of the proposed changes too. It makes the choice of the best variant of solution easier. Simulation can be also used for management of production processes, as a tool for checking the possibility of different production orders realization at different available resources. It can take into account not only manufacturing process but also supply and sale processes. For building of such a complex model, one can approach in two ways: by creating generalized model of the whole system and then extend particular subsystems. On the other side there is possible to create some models of subsystems which will be later jointed into one.

Large labour-consuming is a disadvantage of modelling of such complex production systems. Later it is easily to make different changes in simulation model - to create different variants of the analysed production system. Checking different variants and choosing the proper one can bring significant advantages for the company.

Simulation permits on execution of researches on the worked out model and not on "live" system. Thanks to such researches the increase of efficiency of the production system functioning mainly thanks to the possibility of solving of problems in short time is possible. Possibility of verification of accomplished assumptions before use in practice is its next advantage.

The introduced example and mentioned above advantages from its use testify large usefulness of the modelling and simulation method in dissolving problems connected with management of production processes.

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