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SIMULATION OF COMPLEX LOGISTICAL SERVICE PROCESSES

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Abstract

The world around us is a very complex and multi-parametric system, like the weather, traffic, operation of machines, production processes, service processes, etc. Understanding of the characteristics, operation and behaviour of these systems and processes is not easy due to their complexity. The design of optimal production and service procedures is an essential task for planners. The target is the increasing of the efficiency of the production and service 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 often used analysis tool is the simulation in the production processes. Our aim in this article is to show that the simulation can be used efficiently in case of analysis of service processes, not only in case of production processes. The simulation is available for bottleneck analysis of service activities not only for production processes. In this study the simulation of a service process was realized by the AnyLogic software. The relevance of the simulation technique for analysis of complex service processes is proved by a case study of a service and maintenance activity of a multinational shopping centre.

Keywords
fluid flow, process improvement, mathematical model, simulation.

Introduction

If we analyze the activities of companies, there are production companies and service providers. Analysis and improvement of production processes are common tasks of logistics experts due to logistics is a common process nowadays and it has an important role in supply chains and also in the competition of enterprises. Logistics is the planning, organizing and coordinating of the flow of materials, information, energy, money and values inside a logistic system [1]. The characteristics of logistics services processes are more difficult than production processes, so the analysis of service processes is more complex [2–4]. Let see the service processes of banks, hospitals, hotel chains etc.

The domination of the service sector keeps growing in the world's largest economies as global statistics show in OECD and World Bank databases. Eichengreen and Gupta (2013) argue this as well. More than 63% of world GDP is produced by service sector (CIA, 2013) and this ratio is even greater in countries with higher GDP (more than 75%) [5]. The concept of reorganizing dysfunctional business processes still exists even in the this century. Usually this is with new, more sophisticated tools and methodologies [5].

The most often used analysis tool is the simulation for design, analysis and improvement of production processes. This method especially used for material flow analysis in production processes. In service processes not only material but immaterial (e.g. information, human resource, etc.) goods are flowing. A new definition was introduced for material and immaterial goods, which is the "fluid". In the service processes fluids are flowing, it called "fluid flow".

The research topic is unique, because the aim of the authors is to show that the simulation can be used also efficiently in case of analysis of service processes, not only in case of production processes.

The service fluid flow has different characteristics, like lead time, quality or resource efficiency which are changing continuously in the process. In this study the behavior of this type of service fluid flows is analyzed by simulation method.

In this study the authors would like to introduce the general characteristics of service processes, and mathematical formulation of these which is a new and unique conception. The elaborated mathematical formulations are required for the further establishment of simulation modeling and examination of service processes. For the process improvement and optimization of service processes the objective function should be elaborated, and for problem solving different optimization methods and algorithms should be used.

The main goal of the process simulation is the analysis of bottlenecks and lead times of service processes. If we know the bottlenecks of the system, we can improve it. The *AnyLogic* simulation software was used which support the definition and simulation of the fluid flow in service processes, because the software provides the possibility of setting of not only the material but immaterial goods flow in the model.

Our study provides a general theoretical and practical solution which can be available for examination of real service providers. Authors introduce a real case study for simulation of service and maintenance activities of a multinational shopping centre. Due to this method efficient service processes can be realized with higher customer satisfaction. In case of analysis of very complex service processes only the simulation methods can be used for system analysis.

The study introduces an earlier developed model of the authors. The model was created in an inductive way taken into account practical experiences and theoretical considerations. The focus of the study is the practical application of the model, which is demonstrated in a case study. It is completed in two steps:

At first it is described that the model can be applied for a practical problem which is the operation of a supermarket. The model of the supermarket is built based on the general model.

After it, a simulation model is created from the elaborated model. It is necessary that the model have to be well defined to solve the practical problem. The applied method for the system analysis is the simulation. During the simulation a simple objective function is used, but later examination it could be extended by parameters such as costs, entropy, customers' demands etc. The last section clearly demonstrates that the elaborated general model can be applied successfully in our case study.

Literature review, methodology

This research is absolutely original and unique, because it is confirmed by a case study of this study that the elaborated fluid flow model is correct and the simulation is an effective technique for the examination of fluid flow systems in service processes.

The base of the recent study was a deep literature review which was summarized in [6]. This literature review suggests that numerous techniques and methods are available for business process amelioration. All of them are based on the concept BPR (Business process re-engineering). This concept is the creation of a blueprint of the process structure. Then, significant changes are made to reach better performance and more harmonized process structure. In our terms, BPA (business process amelioration) means something different which can be described by process *logistification*. *Logistification* is the modeling and analysis in terms of efficiency, sensitivity and optimality. It is described detailed in [5]. During examinations, it was noticed that the efficiency of a process is exclusively determined by the object flowing in it and not by the functional department which it partly or fully incorporates [6].

It can be concluded that this research topic is absolutely new and unique [5].

The aim of the mathematical model is to provide a theoretical background to our simulation model and on the basis of this mathematical model the required computing model can be prepared. The mathematical model is based on the new terms of fluid flow [7]. The mathematical model was developed by our research group [7, 8]. The mathematical modeling of the fluid flow service processes is also a novel modeling method [7–11].

The simulation is a frequently used analysis method in logistics for production and material flow simulation [12–14], but not for analysis of service processes. But we can conclude in this study that the analysis of complex service processes can be realized only by simulation method, the mathematical modeling of fluid flow service processes and the application of it for practical applications is unique and new.

After the deep analysis of real-life service providers like banks, hospitals, hotels and trading companies, the authors defined the general characteristics and the specific characteristics of the different sectors. After it the general facts, axioms and mathematical formulations were defined.

The computer model was prepared by reductive method; it was derived from the mathematical model. The case study was also defined based on reductive method. The solving method was the simulation.

The elaborated method is available for process improvement and optimization of real service processes.

Introduction of general characteristics of simulation method for analysis of service and production processes

Analysis of complex systems can be carried out by 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 behaviours 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 behaviour. The model is able to take into consideration only the most important elements of the complex real-world system, so it is 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 behaviour of the real system can be understood by the examination of the model. It is the most widely used tool for decision making [12–14].

VDI (Verein Deutscher Ingenieure, Association of German Engineers) Guideline 3633 [15] 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 [16].

Typical application fields of simulation are the followings:

- design and analysis of production or service processes,
- optimization of supply chains,
- design and analysis of traffic systems, etc.

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

- production and service activities are very complex stochastic processes,
- customer demands are changing extremely fast, which results in
  - changing of production/service volume,
  - changing of product/service variety, or
  - modification of the production/service processes,
- the pressure of continuous cost reduction and efficiency improvement requires optimization and improvement of production/service activities (see [17]).

Simulation analysis of production and service 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.

Random events can be, for example:

- operational problems of machines/equipments,
- 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/service 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.

Concepts, definitions and attributes used in case study

The conceptual system of the fluid flow during service processes was elaborated. A mathematical model was built on this conceptual system. The mathematical model was defined for the most important elements of both service and production [7, 8, 11].

Usually complex systems can only be examined based on their basic attributes. For these problems simulation is an appropriate examination method.

The aim of this study is to define a mathematical model for a smaller-scale service task, then analyze the application of the model by a simulation software.

In this section the most important concepts and definitions of fluid-flow are summarized. The exact definitions in [7, 8] references.

Concepts and definitions

One of the most important definitions is connected to the observed system. The observation takes place in a well-defined organization, which could cover a geographically wide area. In this study the observed system is the system of fluid flow [5]. In real-life applications could be a bank, a hospital, a hotel chain etc.

Definition 1. **Fluid-flow system** (*FFSy*) the observed finite number of elements or objects (enterprise, building, shop, office, etc.) of the dynamic activities of an enterprise. The following attributes can be assigned to the whole fluid-flow system: lead time (Δt), quality (q), resource efficiency (c).

The observed system is surrounded by an environment, with which they mutually affect each other.

Definition 2. Fluid flow environment (*FFE*): set of elements and objects which are in direct contact with at least one element of the fluid-flow system.

The system is dynamic, the concepts always apply to a given $t = t_0$ point of time.

Concept 1. **Flow** refers to the temporal, spatial, or conditional change of a material or immaterial (e.g. information, human resource, etc.) good.

Concept 2. **Fluid** (F): the material, immaterial good taking part in the flow. A natural number f is assigned to each fluid. Fluids have an explicit real value, which is called weight $w(f,t) \in \mathbb{R}$. (This weight refers to the natural dimension (if there is any), quantity, priority etc.)

Example. Define $FS = \{wheat; flour; bread\}$ and the assigned numbers are $\{1; 2; 3\}$. Then $f = 2$ means flour fluid.

Definition 3. **Transfer** means the assignment of a fluid from a node to an other node.

Concept 3. **Node** refers to an element through which the fluid could pass through and be 'transformed'. Nodes appear as an object of a class. Transformations describe their behaviour. Four classes of nodes are used in this study: input node, intermediately outer node, output node, internal node.

Concept 4. **The state of node**: the concept of state is defined in the model and given in details in the simulation model. It contains elements, such as the quantity of wheat in a warehouse at t point of time, or the number of pending documents in an office. It could define whether a customer office desk is available, busy or closed.

Definition 4. **Transformation**. During transformation a fluid changes into an other fluid and/or suffers quantitative changes. This can be described by one mapping methods.

The most important attributes of nodes are: lowest capacity, highest capacity, necessary node, node that is excluded from a given transformation, entropy changes of a node, time of value adding, time of necessary loss, time of queuing, service time, service order etc.

Concept 5. **User** means the resources of a node demanded for transformation and flow.

Definition 6. **Fluid flow** (*FF*) assigned by

$$\left(f, N_i^{y_1}, N_j^{y_2}\right) \tag{1}$$

the transfer of fluid f from node $N_i^{y_1}$ to node $N_j^{y_2}$ (fluid flow).

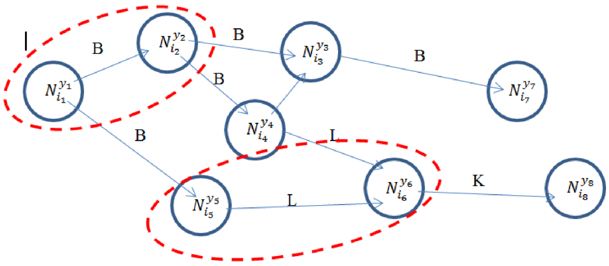

Fig. 1. Fluid flow.

Definition 7. **Fluid flow Sequence** (FFSe)

$$FFSe_f(Q) = \left(\left(f, N_{i_1}^{y_1}, N_{i_2}^{y_2}\right),\right.$$
$$\left.\left(f, N_{i_2}^{y_2}, N_{i_3}^{y_3}\right), \ldots, \left(f, N_{i_{l-1}}^{y_{l-1}}, N_{i_l}^{y_l}\right)\right) \tag{2}$$

ordered series is called fluid flow sequence.

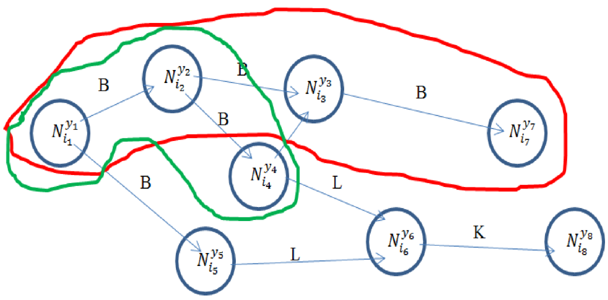

Fig. 2. Fluid flow sequence.

Definition 8. **Fluid stream** (*FSt*)

$$FSt_{f_1 f_2 \ldots f_k}(Q_1, Q_2, \ldots, Q_k)$$
$$= \left(FFSe_{f_1}(Q_1), FFSe_{f_2}(Q_2), \ldots, FFSe_{f_k}(Q_k)\right) \tag{3}$$

is called fluid stream.

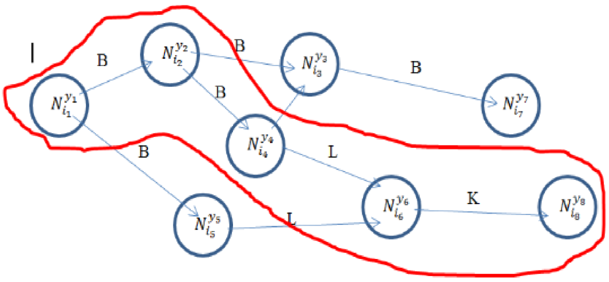

Fig. 3. Fluid stream.

Connecting nodes and fluids (attributes, axioms)

1. In case of one fluid two nodes are connected only by one fluid- flow.
2. Fluid can arrive to a node only by means of fluid flow.
3. A specific fluid flow refers to only one fluid and connects exactly two nodes.
4. The weight of a fluid can only change on nodes.
5. Every transactions connected to the fluid are executed in a node.

The mathematical model of fluid flow is clearly demonstrated by Fig. 4.

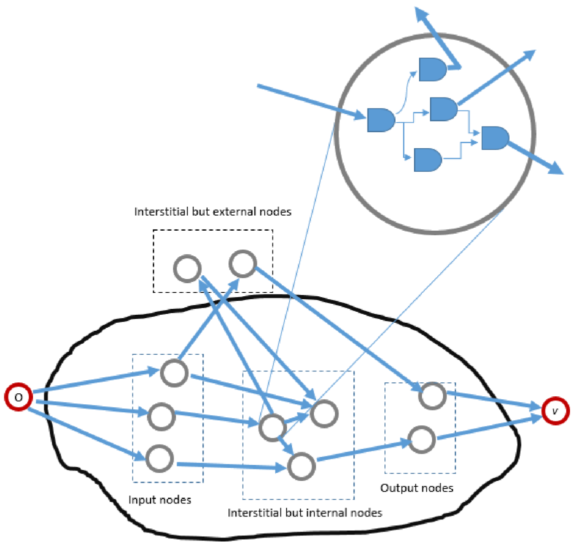

Fig. 4. Model of fluid flow.

According to Fig. 4. the system consists of nodes, and fluid flows are realized between them [7]. In Fig. 4. the input nodes and output nodes are collected to one set. This does not cause any distortion in the model, because more inputs can be merged into a virtual 'input' node defined as 'starting node', and then the original input nodes are also added to the system. The same method can be used for output nodes as well. This simplifies the simulation task, since this way it is enough to define only one starting and one final stage.

The nodes of the mathematical model are assigned to several groups, although in the simulation model these nodes appear as objects, therefore only one class of node is needed. The differentiation of nodes will be assured by their methods and attributes. This significantly simplifies the formation of the simulation process without distorting the original model.

Case study: Definition of a special service task – service and maintenance of a multinational shopping centre

The fluid flow will be demonstrated by the internal structure of the service and maintenance of a multinational shopping centre. The following Fig. 5. shows the internal structure of the maintenance service.

As it emerges from Fig. 5 demands flow into the administration service centre as inputs. Demands can be assigned to 4 main categories there, as follows:

1. Technical transcription of tools:
   - receipt of equipments,
   - setup,
   - ensuring support,
   - guarantee and warrant demands.
2. Operation demands:
   - scheduled maintenance tasks,
3. Demands of partner departments:
   - information issues,
   - problems with office equipments.
4. Failure report:
   - utility-type failure,
   - installation failure,
   - information failure.

The listed demands arrive to the administrative service centre as fluid, where they stand in a line to waiting list ordered by taking into account different operational aspects. Then the demands arrive to an administrator. The administrators freely receive the demand, or they are busy, or they are out of office. In case of the latter two situations the fluid continues waiting. The fluid goes under transformation while at an administrator then proceeds to the technical control/directorial group. Then it similarly queues in a waiting list. When the status of the technical controller is free they receive the demand and decide which maintenance group should it be sent to, so the fluid goes under further transformation. Furthermore their task is to purchase any needed components.

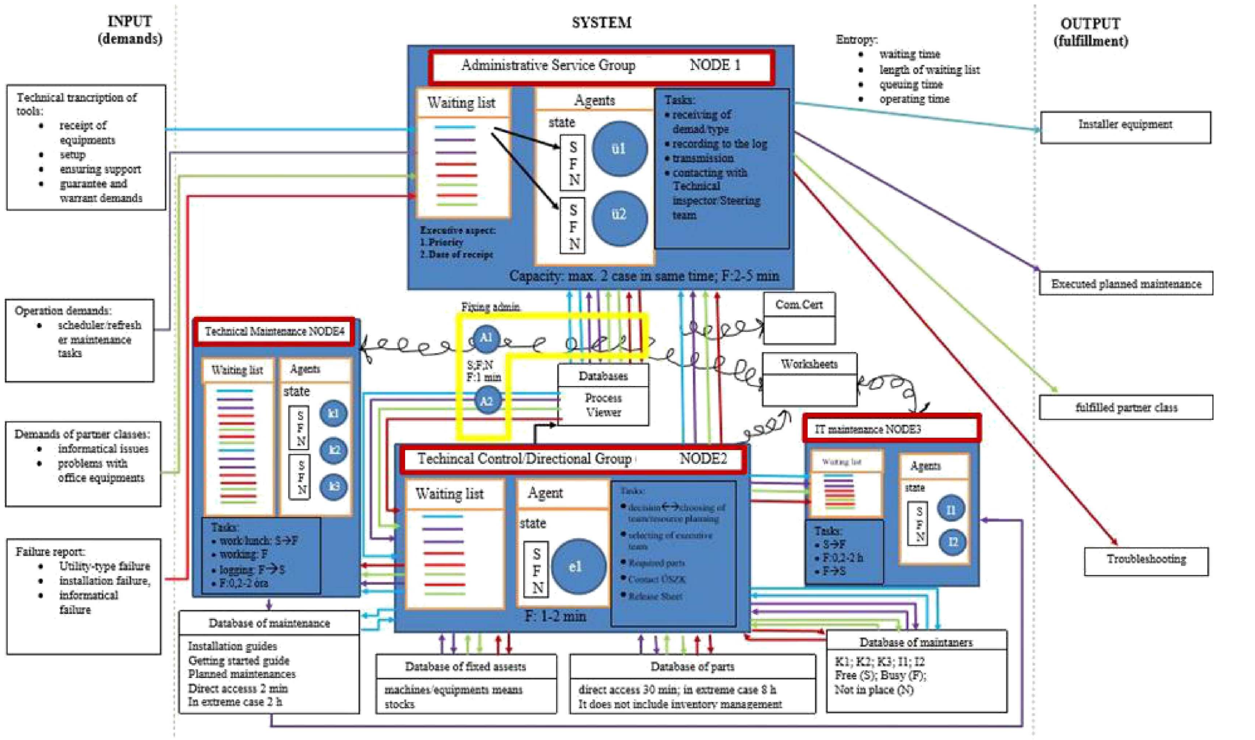

Fig. 5. The internal structure of the service and maintenance of a multinational shopping centre.

In our example there are two computer engineers on the Information Maintenance Group and three repairmen in the Technical Maintenance Group. Regardless to the direction of the information it queues to a waiting list similarly to the former nodes, where the waiting time depends on the busyness of the repairmen. Here the fluid turns into its final state after transformation. The output is also divided into 4 groups depending on the taking-over certificate, worksheets and databases containing further information:

1. installer equipment,
2. executed planned maintenance,
3. fulfilled partner department,
4. troubleshooting.

The case study demonstrates the process of fluid flow by the use of 4 nodes (Administrative Service Group, Technical Control/Directional Group, Technical Maintenance, Information Maintenance) 8 users (administrators (2), technical controller (1), computer engineers (2), repairmen (3). The connection of users in the same node or in different nodes and the performance and expertise of the users play an important role, since they all affect the flow. In this example a role is given to different databases, mandatory forms to fill which demand certain amount of capacity and time, but they are essential for a long-term and sustainable operation.

Modeling the service task – multinational shopping centre

In this case study the system of the fluid flow is an internal organization of service and maintenance. The environment of the fluid flow is a multinational shopping centre.

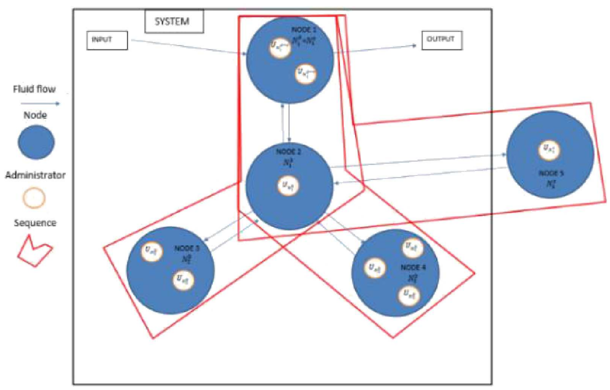

Fig. 6. Model of sample task- multinational shopping centre.

Fluids:
1. Technical receipt of tools.
2. Operation demands.
3. Demands of partner departments.
4. Failure reports.
5. Transfer of the receipts of tools to the Technical control group.

Nodes:

N_1^p is assigned to the Administration Service Group (*ASG*),

N_1^b is assigned to the Technical Control/Directional Group (*TCDG*),

N_2^b is assigned to the Information Maintenance Group (*ITMa*),

N_3^b is assigned to the Technical/General Maintenance Group (*TecMa*),

N_1^s is assigned to the External service providers (the simulation does NOT include this),

N_1^o is assigned to the Administration Service Group (identical to the input node).

$$n = 6, \quad |\mathcal{N}^p| = 1, \quad |\mathcal{N}^s| = 1, \quad |\mathcal{N}^o| = 1,$$

$$|\mathcal{N}^b| = 3, \quad n = n_p + n_s + n_o + n_b,$$

$$FS_{N_1^p} = \{1; 2; 3; 4\}.$$

Users:

The Maintenance system uses 8 users:

1. U1 administrator 1.
2. U2 administrator 2.
3. E1 technical controller/dispatcher 1.
4. I1 computer engineer 1.
5. I2 computer engineer 2.
6. K1 repairman 1.
7. K2 repairman 2.
8. K3 repairman 3.

Users assigned to each node:

$$U_{N_1^p} = \{1; 2\}, \quad U_{N_1^b} = \{3\}, \quad U_{N_2^b} = \{4; 5\},$$

$$U_{N_3^b} = \{6; 7; 8\}, \quad U_{N_1^o} = \{1; 2\}, \quad U_{N_1^s} = \{x\}.$$

Introduction of AnyLogic simulation software

Fluid bundles are used in the simulation model of fluid flow, which allow more fluid to flow at the same place, and different fluid can flow through the same channel. The principle that the fluid can transform only at nodes and by users is also used in the simulation model [18].

The application used for the simulation was: AnyLogic 7 Personal Learning Edition.

Anylogic is a simulation modeling software that uses the language of graphical modeling, and can be complemented by Java code. Its flexibility allows the modeling of complex and unique social and economical systems with high level of elaboration (Source: www.anylogic.com/features).

Discrete event model technique was used for the solution of the task [19, 20].

AnyLogic software provides the possibility of setting of not only material but immaterial goods flow in the model. Service block was applied for the definition of nodes. This block occupies resources, in this case users, and delays (transforms) them with a delay time parameter given in advance, then let the fluid proceed. The delay time parameter was defined by a triangle distribution function built in the software. The block that creates resources for the service block is called resource pool. The number of users is given by the capacity parameter.

The following figure (Fig. 7) shows the structure of the case study built in the simulation application.

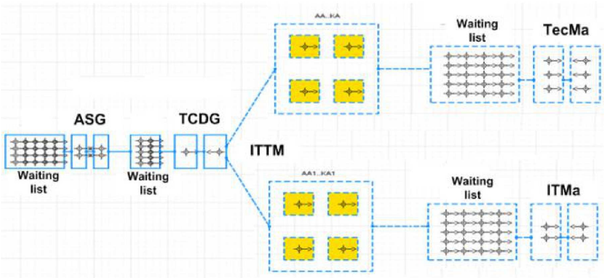

Fig. 7. Layout of the model.

The elements appearing in the flow are visualized by geometric shapes (Fig. 8).

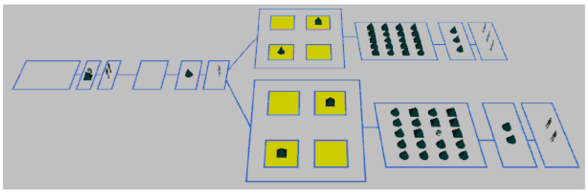

Fig. 8. 3D model during running.

The immaterial fluids are created by the source block, used for the production of agents. The technical transcript of tools, operational demands, demands of partner departments, and failure report input fluids are flowed during the simulation.

The run of the simulation of case study and its results

Scenario I.

The goal of the simulation is to find the bottlenecks in the service process.

The issues during the simulation arise from nodes "TA", "TB", "TC" and failure report source blocks. The frequency of generation can be defined by arrival rate parameter. In this simulation it was set to an average 1 problem (failure) in every 10 minutes. After appearance the problems arrive to a node called "ASG" (Administrative Service Group) where two users "U1" and "U2" receive them. One problem can arrive to only one user. When both users are busy the problem gets into queue state. The service and transfer of problems is done by the delay function. The service time can be defined by modifying delay time parameter. In this case it is minimum 2, average 3.5 and maximum 5 min.

After service the problem transport from "ASG" (Administrative Service Group) node to the also service-type "TCDG" (Technical Control/Directional Group) node with one user. Here the service time is minimum 1, average 1.5 and maximum 2 minutes. After service the problem arrives to a *selectoutput* type block called "ITTM", where after giving the probability or condition parameter the simulation decides whether the problem is technical or information type. For the sake of simplicity this example applied probability parameter with a value of 0.5 (Fig. 9).

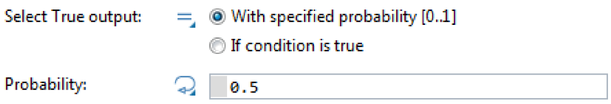

Fig. 9. Setup of parameters.

After selection the problem arrives to a selectoutput5 type block, where, also with the use of probability parameter, the simulation decides what kind of supplementary activities are needed for the solution. The supplementary activity can be accessing maintenance database (KA), accessing fixed assets database (AA), accessing component database (LA), accessing repairmen database (HR), and it is defined by a delay type block. The time of service can be defined by modifying the delay time parameter. After the execution of the chosen additional activity the problem arrives to the "TecMa" (technical repairmen) (with 3 users) or to the "ITMa" (information repairmen) (with 2 users) service type block. In case of maintenance the delay time parameter is set to minimum 12, average 66 and maximum 120 min for both cases. The problem finally ends at end3 and end4 sink type blocks (Fig. 10).

The run of the simulation simulated 10 hours of operation. The examined points included the usage of the nodes, the lead time of administration, technical maintenance and information maintenance. The graph shows that the average administration time is cca. 6 min, the average technical maintenance time is cca. 230 min, and the average of information maintenance is cca. 280 min. All the arrived fluids during the 10 hours intervals were processed, and used for statistical analysis. It is visible that the lack of information repairmen (ITMa) and technical repairmen (TecMa) are the bottlenecks during the run.

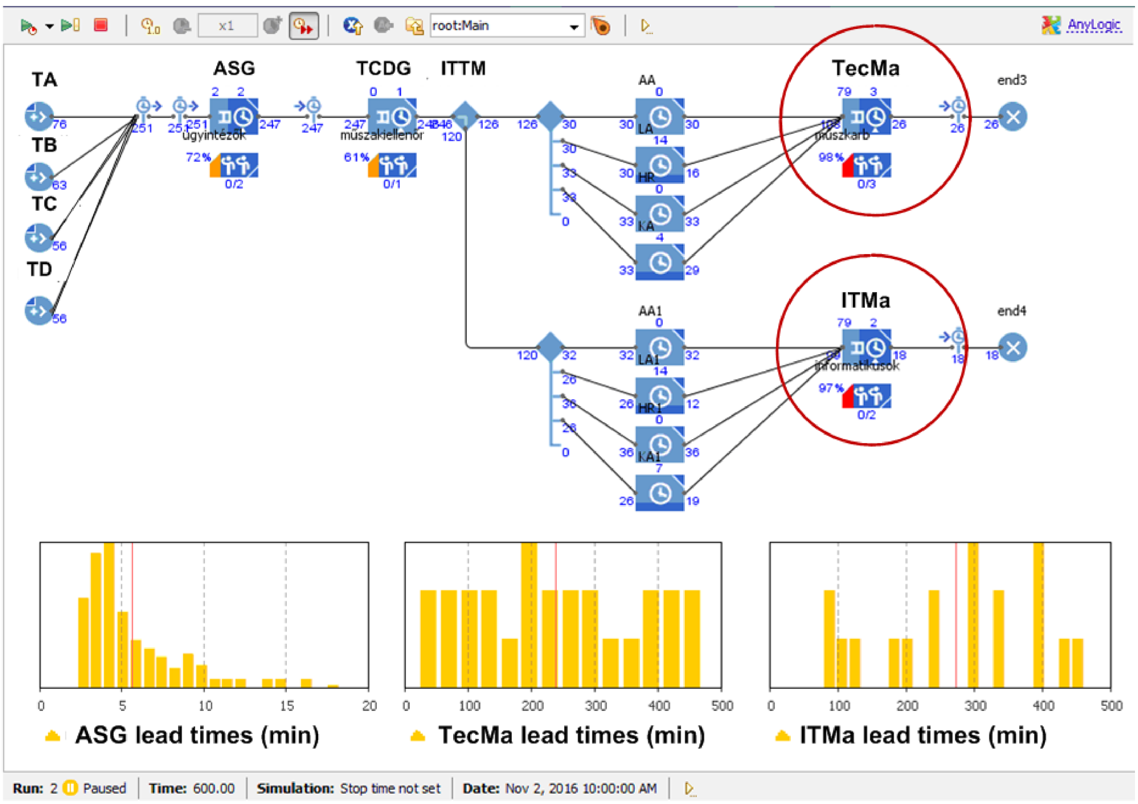

Fig. 10. Result of simulation (Scenario I, bottlenecks are highlighted by red circle).

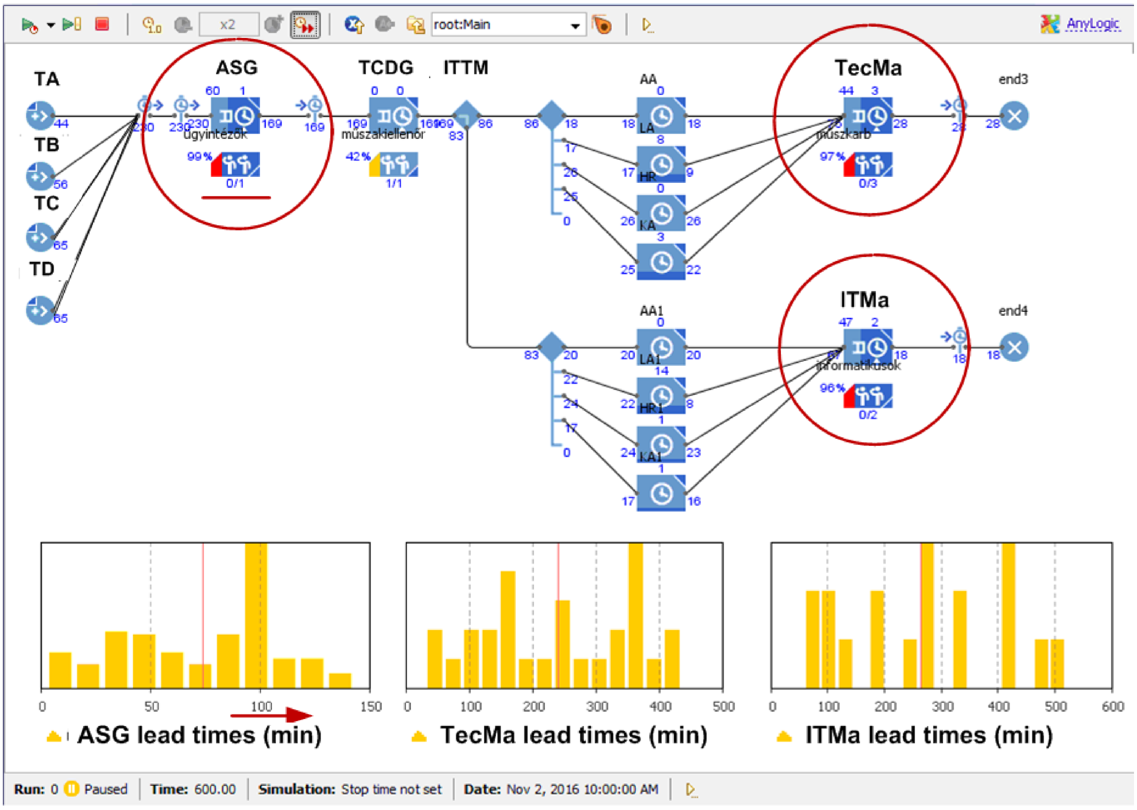

Fig. 11. Result of simulation (Scenario II, bottlenecks are highlighted by red circle).

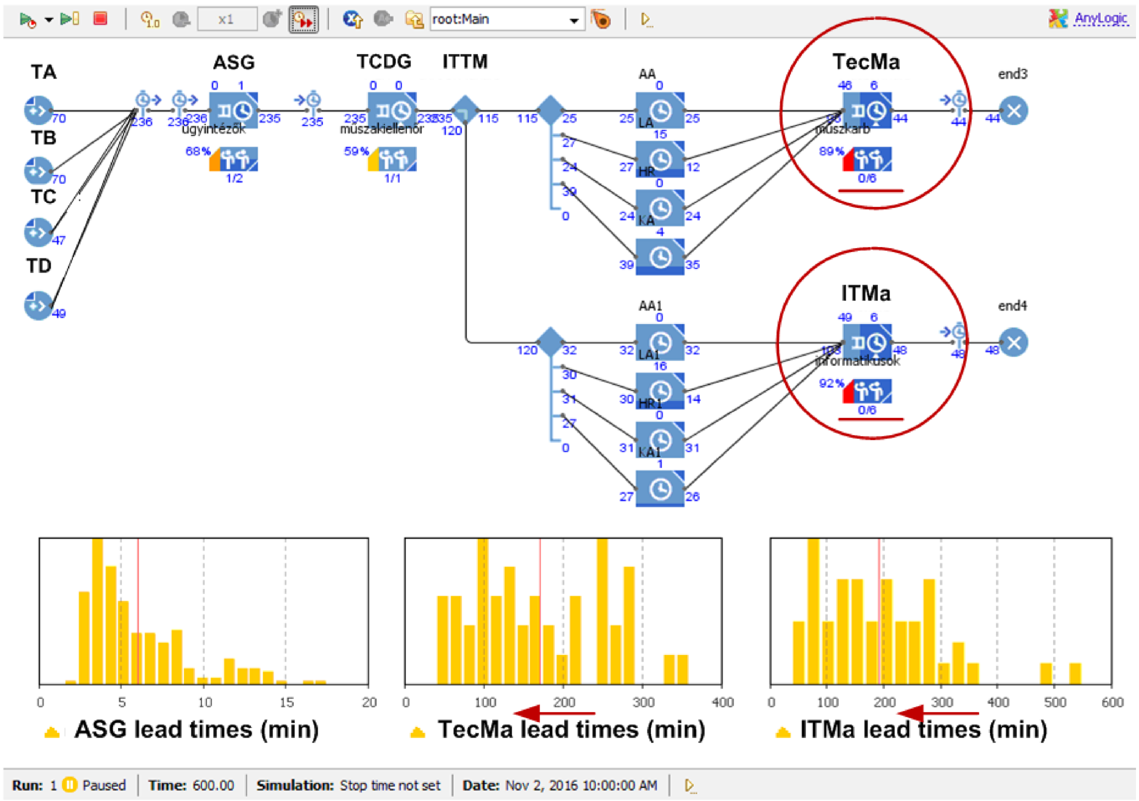

Fig. 12. Result of simulation (Scenario III., bottlenecks are highlighted by red circle).

Scenario II

The simulation was run in a case when only one administrator (ASG) was able to receive fluids, the other one was inactive. In this case the lead time of administration increased significantly, but the lead time of technical and information maintenance remained unchanged (Fig. 11).

Scenario III

Then a simulation was run in which the number of information (ITMa) and technical repairmen (TecMa) was increased (from 2 persons to 6 information repairmen and from 3 persons to 6 technical repairmen). By enlarging their number the lead time of technical and information maintenance significantly dropped (Fig. 12).

Results of the simulation

It is clearly visible that in our case study in case of all of three scenarios the bottleneck problem arises mostly in "TecMa" (Technical Maintenance Group) and "ITMa" (Information Maintenance Group) nodes, in particularly due to the lack of maintenance.

The administrative nodes are not critical so these have not effect on the efficiency of the system.

In our case study it can be concluded that the information and technical maintenance activities should be improved to eliminate bottleneck from the service process.

These data provided by the simulation results can help the strategic decision making of general management, optimization of service processes and making short and long term operative plans.

A general fluid flow model was applied for an existing service problem. It shows that the model is usable for service problems. The model is also suitable for computing examination. A simple objective function was used in this example, but it can be extended with cost, entropy, etc. The simulation corresponds to the test of the model of fluid flow. Also, this simulation method can be applied for the sensitivity analysis.

Conclusion

The paper summarizes the typical application fields of simulation and the reasons for application of it in field of service processes.

This research is original and unique, a new definition was introduced for material and immaterial (e.g. information, human resource, etc.) goods, which is the "fluid". In the service processes fluids are flowing, it called "fluid flow". In the service processes (which are a fluid-flow system) these material and immaterial goods are flowing between elements and objects (e.g. enterprises, buildings, offices, shops, computers, etc.).

The paper introduced a "fluid flow model" for modeling of complex service processes (e.g. banks, hospitals, hotels and trading companies etc.).

The goal of the authors was to show that the simulation can be used efficiently in case of analysis of service processes, not only in case of production processes.

The simulation procedure was demonstrated by a case study of a service and maintenance activity of a multinational shopping centre. The AnyLogic simulation software was used which support the definition and simulation of the fluid flow in service processes, because the software provides the possibility of setting of not only the material but immaterial goods flow in the model.

If there is an existing available model then it should by always applied to a particular problem. It was shown by a simpler case study that the model could be fitted to a given task, so that it could be used for service processes as well. The result of the simulation run showed that the given solution technique is appropriate for finding the bottlenecks of the fluid flow, and due to the easily changed parameters the settings allows the evaluation of different scenarios.

This research is absolutely original and unique, because it is confirmed by a case study of this study that the elaborated fluid flow model is correct and the simulation is an effective technique for the examination of fluid flow systems in service processes.

The simulation model and software due to the easily changed parameters can be used for all type of service processes.

The efficiency improvement of the service tasks was ensured by simulation method. The bottleneck analysis showed the critical points of the system, where the service task can be improved. Authors elaborated scenarios for process development. Modifying the system parameters the global efficiency of the service process can be increased, the lead times of the critical operations can be reduced. Simulation method is absolutely good possibility for evaluation of service processes in case of more complex service activities, constraints and objective functions.

The mathematical model developed by authors is a completely new result according to our research introduced in chapter "Literature review, methodology". The application of the elaborated model for a service task also appears as a new result, since it shows the practical applicability of our theoretical model, furthermore it provides the basics for an analysis by simulation. This analysis is directly connected to practical application. The results of the analysis can help the strategic decision making of general management, optimization of business processes due to the evaluation of different scenarios.

In the future we are planning to analyze the application possibilities of the model in case of different companies. The goal is to develop a software based on this theory, and the sensitivity analysis in general has to be solved as well.

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