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THE USE OF SIMULATION MODELS FOR THE OPTIMIZATION OF TRANSPORT AND LOGISTICS COMPANY PROCESSES

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Abstract: *The paper deals with the applications of modeling and simulation tools in the optimization of transport and logistics processes in the company. As a modeling tool was selected Simul8 software that is used to process modeling based on discrete event simulation and which enables the creation of a visual model of production and distribution processes.*

Key words: *modeling and simulation of processes, SIMUL8, model of logistic processes, linking theory with practice, transport logistics.*

1 INTRODUCTION

Computer modeling and simulation can now be considered as an essential tool in streamlining of logistics processes and production systems. Appropriately designed models allow us to imitate and observe the properties of individual processes and to predict their behavior. Computer simulation can be considered as an important facilitator of problems solution requiring the use of such methods and means of support, which allows a comprehensive approach to designing systems and quickly tried various solutions and minimize the risk of erroneous decisions.

2 COMPUTER SIMULATION OF LOGISTICS PROCESSES

In the term of simulations we understand an experimenting with the computer model of a real system. Simulations eliminates the shortcomings of analytical methods, but is also more time-consuming (for example model building, model testing, planning and execution of experiments) as well, as in the preparation of input data. In the way of creating the simulation models it is possible to use appropriate simulation software, which is available on the Czech market. For the purpose of solving the logistical problems we use the simulation program SIMUL 8 [1, 2], which is designed for process modeling based on discrete event simulation. Discrete event simulation is commonly known method of analyzing the behavior of the modeled systems by experimenting with the computer model. SIMUL8 is designed for planning, designing and optimizing of real processes of company production, company logistics and also the provision of services. In this program, the user forms a visual model of the investigated system and the animation of its run. A visual model is then used to view the structure of the modeled system, understanding links and system operation.

When you create a simulation model, it is appropriate to continue with these consecutive steps [4]:

1. Determine the objectives of the simulation model - what you might expect, the scope and needs of created simulation model;
2. Collection of data that are needed for the simulation - based on exact data from the real system;
3. Building a simulation model - creation of model parameters;
4. Review of the assembled model – if the model satisfies the requirements set out in the objectives, model functionality;
5. Simulation experiments implementation - looking for system improvements, verify their effects on the modeled system;
6. Incorporating the results in real system - improvements with regard to the real system;

3 SPECIFIC SITUATIONS THROUGH A SIMULATION MODEL

If we transform the above steps for the specific example of the practice, it is appropriate to divide these steps with regard to the general regulations for the creation of simulation models for each phase. A practical example might be the use of specific simulation model in solving the transport-logistical problems in the company DEZA a.s. [3]. The main target was to analyze the problem situations and to create a function model using the Simul8 software. The model was focused in the aim of solving the optimization of transport and logistic company processes with regard to the continuous and gradual increase in road transport, which leads to uncontrolled or poorly managed accumulation of trucks in the company and the problems associated with the appropriate organization of trucks loading and unloading.

The output of the simulation model was the proposal of technical and organizational changes in the company, such as the construction of a new retaining parking, change of the vehicles movement along traffic routes in company, the organization of loading and unloading capacity released exactly as loading and unloading sites, locating suitable sites of gatehouse, expedition and related departments of loading and unloading.

3 PHASES OF SPECIFIC PROBLEMS SOLVING

Custom solutions of a simulation project, was implemented in different phases of technical and organizational changes.

Phase 1: Identifying the problem and setting the objects

Formulation of the problem is a major step in the success of a simulation project. In this phase the following objectives are:

- Optimize transport and logistics processes in the company with regard to the steady and gradual increase in road transport.
- Optimize uncontrolled and impact accumulation of trucks in the company.
- Optimize the organization of truck loading and unloading.

The target state of the problem should ensure that trucks used (or ordered) for loading or unloading will either commute to the agreed time of loading or unloading, or will wait for the parking outside the detention premises of the company. The places of loading or unloading will be released only in the event that spare capacity and will be announced by information system. Main problems with unwanted vehicles in the company, with all the current negative impacts, will be by the model solved.

The aim of simulation model was consisting in main three problem situations:

1. With an average weekly truck arrival.
2. With the increased average truck arrival at daily highs.
3. With daily peak truck access.

Phase 2: Building a conceptual model

At this stage of creating the simulation model was creation of the conceptual model of the system. Using this model is possible to get a basic idea of the system being modeled. Conceptual model can be based on the basic rules of his creation:

- What business system we modeled?
- By what criteria is evaluated the effectiveness of the system?
- How detailed level modeling is necessary?
- What objects, activities and resources modeled system will include?
- What are the rules of operating requirements?
- How to allocate limited resources to individual processes?

Phase 3: Data Collection

With regard to exactness of a formed simulation model was necessary to provide the data, that were obtained by detailed mapping of the current load state of the roads and the time values of truck loading and utilization of employees in the company. With regard to the objectives, data were obtained from the following areas:

- Frequency of arrivals of trucks and its weight load- annual statistics;
- Frequency of arrivals of trucks and its weight load - daily statistics;
- Time value of loadings on individual company sites;
- Working time and the movement of workers in the factory;

It was possible now to determine the frequency distribution of the actual truck arrivals from these data to determine the values that are most relevant for modeling.

From the collection and evaluation of data there were three categories designed for simulation experiments:

- The average daily arrival of trucks – even distribution;
- The average daily arrival of trucks – maximum distribution;
- For daily driveway tip of trucks – peak distribution;
-

Phase 4: Development of a simulation model

Based on the conceptual model was created simulation model (Fig. 1), on which were set all model elements according to prepared data. After the first run it was necessary to tune the model in the way of functional entities (vehicles) in the required amount passed, which will pass through the system smoothly.

In the way of creating a simulation model has been set priority simulation inputs and fixed objects, that model contains. They are mainly

- Entities (cars) - sets the number, time of arrival, remaining in the system;
- Loadings - set the delay entity for the duration of the activity;
- Paths (communications) - the number of system interconnection capacity (time to entity);
- Trays - tray entities;
- Deployment and interconnection of individual objects;

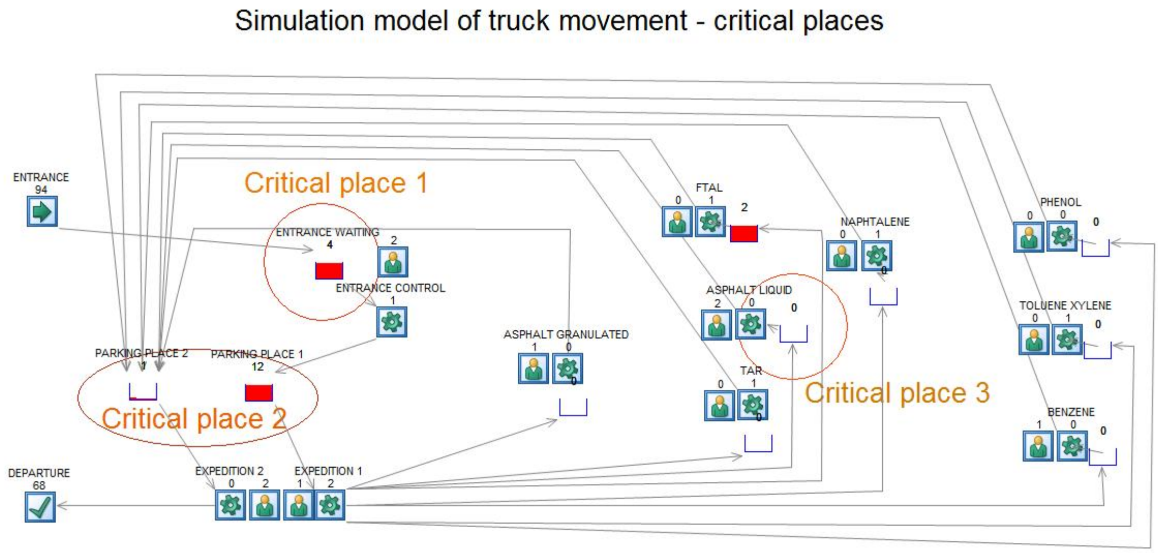

Fig.1 *Simulation model of truck movement (before optimalization) - Source [3]*

Phase 5: Verification and validation of simulation models

In the term of model verification we mean, that the created computer model is consistent with the original conceptual model. As a validation we understand the verification, that the computer model is consistent with reality. In the validation we verify whether our idea of the workings real system was correct [4].

An important step of verification and validation in the simulation model has been setting of the relay of operations to show the best reality of the business. The actual relays of operations are different in the various departments as well, as the length of working time. Some activities are during relays strengthened as necessary by the movement of workers. In the model solution we chose distributions of relays that these facts respects. Since the model was created by the existing system, there has been inspected comparison of model outputs with real company values. Comparing the outputs of the selected model with real values demonstrate its functionality with high consensus.

Phase 6: Simulation model experiments and analysis of results (implementation in practice)

Results of simulation outputs usually show the value of each element (entity), which is located in the simulation model. They mainly are:

- Utilization of loading - regardless to the maximum capacity;
- Crowded places - the number of entities in the trays;
- Utilization of human resources – personnel utilization;
- Outcomes of experiments in numerical and graphical form;

Experiments with the simulation model were made at these levels and initial conditions:

1. Entrance to the complex and individual truck loading evenly distributed;
2. Entrance to the complex and individual truck loading at the maximum capacity values;
3. Entrance to the complex and individual truck loading at day peaks;

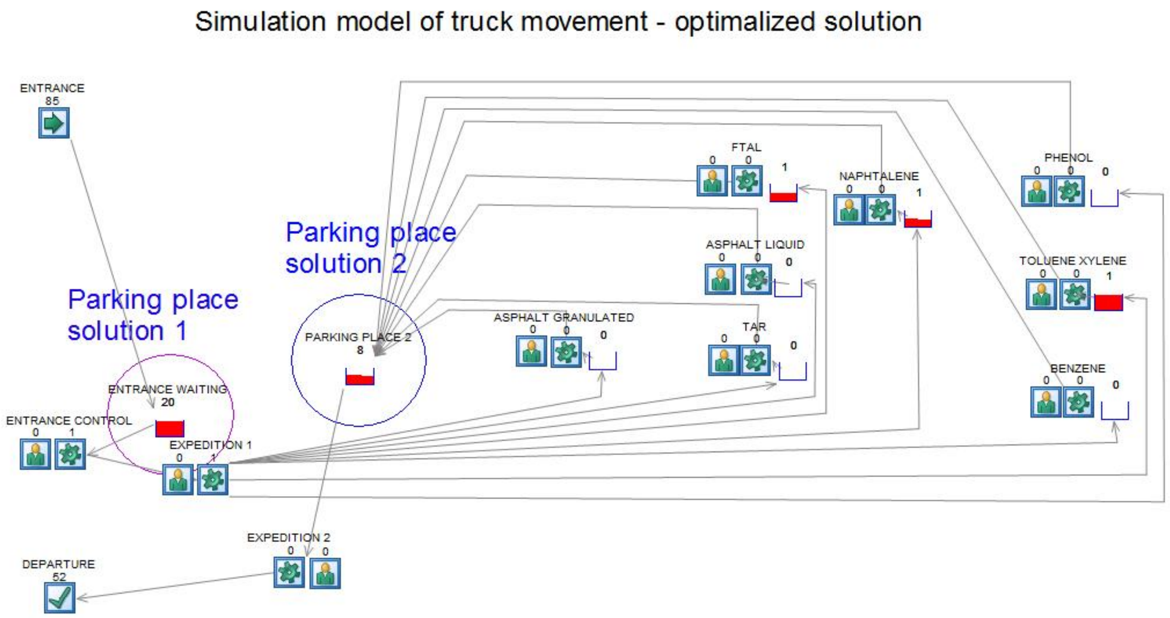

Fig.2 *Simulation model of truck movement (optimalized model) - Source [3]*

Based on the simulation experiments were detected the bottlenecks in the system, made the adjustments of the system and created an optimized model of the proposed solution (Fig. 2), which was performed by additional experiments leading to the determination of optimization solutions. Solutions were designed in the areas of roads utilization in the company area, in the staffing sector, in the flow of traffic for internal communication and fluency loading of raw materials. The new solution allows, among other things, that trucks were sent to the loads in a controlled manner at the direction, that the loading capacity available. The results of the simulation model became the basis for the preparation of internal project documentation for the relocation of gates and adjusting the movements of trucks in the company area.

***Tab. 1** Evaluation of simulation models in [pieces] – Source [3]*

Evaluation of simulation models - basic indicators						
	Current solution			Proposal for a new solution		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Average daily entrance	32	45	49	32	45	49
Total trucks entry	178	244	75	170	240	74
Blocking the entrance	0	0	6	0	0	0
Cast gatehouse	1/1	2/2	2/2	1/1	1/1	2/2
Using of the parking place 1	7	12	14	0	0	0
Cast expedition 1	1/1	2/2	2/2	1/1	1/1	1/1
Cast of asphalt loading	2/2	2/2	2/2	2/2	2/2	2/2
Cast of naphtalene loading	1/1	1/1	1/1	1/1	2/2	2/2
Cast of FTAL loading	1/1	1/1	1/1	1/1	2/2	2/2
Using of the parking place 2	12	12	14	10	10	8
Cast expedition 2	2/1	2/2	2/2	1/1	2/1	2/2
Total departure	158	222	41	156	218	41
Additional time to complete dep.	0	0	2	0	0	2
Total labor costs	41 100 CZK	61 500 CZK	/	36 500 CZK	43 200 CZK	/

Table comments:

- Cast workplaces – working shifts are divided as follows: 6am to 11pm and 11am to 15pm. Cast 1/1 means that at the workplace is one worker from 6am to 15pm, cast 2/1 means that at the workplace are two workers from 6am to 11am and 1 worker from 11am to 15pm.
- Parking places 1 and 2 have the actual capacity of 10 parking spaces - the number of parking spaces shows, how many places were really busy or a vehicle becomes outside the parking area
- The new parking place is not in the table. The simulations shows that peaks were at 17 parking spaces, designed capacity of the new parking place should be around 22 parking spaces.
- Rates of pay - crucial professions were monitored and evaluated for labor costs. New solution has weekly and annual savings.

4 CONCLUSIONS

Using of modeling and simulation programs, in the way of solving the logistical problems, has its own distinct place in terms of proper articulation of decision-making processes and simulation tools.

Simulation experiments can reveal problems and complications that should occur only in normal operation, thus saving considerable costs, which we had to spend on their removal. In some cases, it is virtually impossible in practice to try various solutions due to the irreversible steps or a very expensive process. Simulation models are able to solve those situations by the much cheaper way. Modeling and simulation can be very powerful tool for optimizing business processes.

Modeling process is particularly well known in connection with the manufacture, production processes and like a diagnostic tool of the effectiveness and planning. Possibilities of applications of simulation software can be found also in other sectors of human activities, such as human services and education [5, 6]. The aim of this paper was primarily to outline options for the use of simulation models in practice, particularly in the transport and logistics solutions to solve problems in society and to show one of the many possible ways of their application in production and transport logistics.

References

[1] SIMUL8, Corporation. SIMUL8 Manual and simulation guide. Glasgow: 2004. 362 s. ISBN 0-97081-100-4.

[2] HAUGE, Jaret W.; PAIGE, Kerrie N. Learning SIMUL8 : The Complete Guide second edition. Bellingham: 2004. 978 s. ISBN 978-0-9709384-3-5.

[3] MENC, P. Optimalizace pohybu vozidel při nakládce a vykládce ve společnosti. Diplomová práce. Přerov: 2014. 72s.

[4] DLOUHÝ, Martin, 2007. Simulace podnikových procesů. Vyd. 1. Brno: Computer Press, 201s. ISBN 978-80-251-1649-4.

[5] SEDLÁČEK, M. Modelační a simulační software Simul8 a možnosti jeho uplatnění v logistice cestovního ruchu. Acta Logistica Moravica [online]. 2013, č. 1. ISSN 1804-8315.

[6] SEDLÁČEK, M. Modelování a simulace výrobních a distribučních procesů ve výuce. In ITL – First International Conference on Aplication of Modern Information Technologies in Logistics. College of Logistics in Přerov: 2013. 136 s. ISBN 978-80-87179-32-1