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The Technological Problem of Simulation of the Logistics Center

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***Abstract*—**Planning of infrastructure and processes in logistic center within the frame of various kinds of logistic hubs and technological activities in them represent quite complex problem. The main goal is to design appropriate layout, which enables to realize expected operation on the desired levels. The simulation software represents progressive contemporary experimental technique, which can support complex processes of infrastructure planning and all of activities on it. It means that simulation experiments, reflecting various planned infrastructure variants, investigate and verify their eligibilities in relation with corresponding expected operation. The inducted approach enables to make qualified decisions about infrastructure investments or measures, which derive benefit from simulation-based verifications. The paper represents simulation software for simulation infrastructural layout and technological activities in marshalling yard, intermodal terminal, warehouse and combination between them as the parts of logistic center.

***Keywords*—**Marshalling yard, intermodal terminal, warehouse, transport technology, simulation.

I. Introduction

LOGISTICS centers must be constantly maintained and renewed for still fulfill its role. The main mode of transport in the continental logistics centers should be rail transport in relation to transport all kinds of cargo units.

This creates urgent task - on the one hand, to offer better quality of service and on the other hand is the need to minimize the costs of infrastructure and operation. For solving such the problems are available several options. The basic options include building a logistics center just with the connection of rail transport as a basic mode for the transportation of goods from the sender to the customer. Due to the large number of variations of elements and technological processes in the construction a logistics center is very difficult to choose the right combination of modifications and don´t make mistake [2].

It is a clear necessity of using computer assisted simulation model. This gives the user the option to simulate and evaluate in this model and all the possibilities for modifications before applying them in reality. This applies not only to the current device, but for an entirely new service. In the paper are presented the basic issues and challenges relating to technologist in creating and using simulation tool a logistics center [5].

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II. Modelling of Railway Transport

Major logistics task of transport is relocation as important service activities. This component is often termed transport logistics. The process itself consists of movements along the transport path and the necessary manipulation (service processes) applied to vehicles and transported commodities so-called (transport) logistics centers [1].

The movement of goods is a complex of service activities that deals with the implementation of specific transport systems.

In addition to rail transport routes the technical implementation of relocation usually requires expensive and considerably mobile sources, such as railway locomotives and wagons. In order to minimize these sources, they are usually not moved by elements after one, but collectively in groups, in so called transport complete [7]. Due to the speed limits of particular transport modes is not the largest relocation timeframe. More important point of delays in transport goods are the transport terminals [3].

A. Transport Terminals

Transportation terminals are also known as logistics centers. They are places of the transport system which perform the sorting transport elements from one set to another.

Some of the most famous types of transport terminals in railway transport are:

- The marshalling yards, where the wagons are sorted between transport set (freight trains) for individual destinations.
- Container terminals, which have multimodal dimension similar as the passenger terminal (typically they meets rail, road and waterborne), but their function is sorting (transshipment) of containers.
- Warehouses, which function is to balance unevenly dimensioned material flows in terms of time, space and product range.

Transport terminals are among the most complex and comprehensive service systems. They include expensive and complex technical equipment and complicated technological processes [1].

They have been designed and managed so as to ensure the necessary performance and quality of service processes at minimum cost to the utility source. This can be achieved by various means. Some of them are modification of infrastructure, use of alternative types of resources, improving the work schedule of resources, improvement of technological processes, modification of decision-making strategies or complete reengineering of transport terminals.

Due to the high complexity of transport systems the application of exact mathematical methods are very limited.

Classical expert studies without using objective tools of management do not give sufficiently objective arguments and this may cause concerns for the decision or even aversion to implement any rationalization measures [8].

In relation to transport terminals various problems are solved and also with varying degrees of complexity. We can divide these problems into two basic categories - spatial planning (design) and planning processes of technological activities, including the management of employees' work.

B. Simulation Model of Transport Terminal

Computer simulation is a method that is used for analysis, evaluation and optimization of systems that exist or could exist. The basic process includes building a computer simulation model, abstraction, experimentation, interpretation and use of the results [4].

The most effective tool for solving problems of transport terminals satisfying these requirements is simulation model of the transport terminal. The principle of simulation techniques is the replacement of the existing or the designed transport hub by dynamic computer model of the hub, which reproduces well the processes and animates the real system. This method allows the experimenter to verify the computer to simulate the series of different operational scenarios of terminals [6]. Consequently, in practice, he can recommend the implementation of such measures, which verify the simulation model and has led to the terminal operation at the required qualitative and quantitative level.

In case of simulation of systems with a high degree of complexity, there are different ways of entering restrictions:

- Methodological and mental encompassment of the model at all its complexity,
- Encompassment the change management for formed product - simulation model, which requires the highest degree of flexibility of the model.

Creation of models in rail transport is actually dealing with two at first glance significantly distant disciplines. The first and also keys´ discipline is area of information technology, namely technology creation and use of simulation models of complex service systems. The second discipline is the area of transport technologies, in particular technologies in marshalling yards, intermodal terminals and warehouse [7].

Although such connection may be a little unusual, in this case it is deliberate. If the task is to establish the quality transport engineers in rail transport, they shall have acquired not only technological disciplines transport but also the various simulation techniques [1].

There is displayed the demonstration processing the technological process of ending train in Fig. 1.

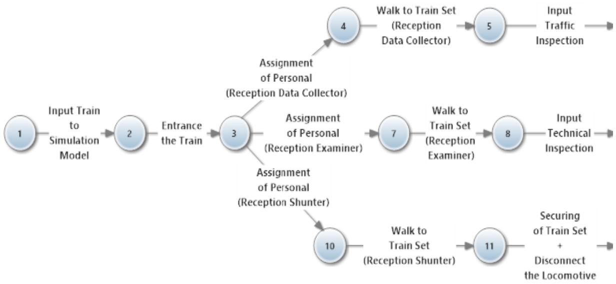

Fig. 1 Example part of technology activities of ending train

III. Modeling of Transport Operation Processes in the Logistic Center by Using the Tool Byron

Simulation model of the logistics center, enables modeled and simulate the various processes in one common the configurable applications. The aim of the simulation model is a logistic center, which can contain any combination of modules:

- Marshalling yard
- Warehouse
- Intermodal terminal

A. The Links between Modules

There are created relations between all the modeled modules. Output current requirements of any module can be directed to the input current requirements in another module, possibly outside the simulation model (completes went the simulation) [3]. A technologist has available all these variants in all modules in process of setting each part.

This option explains to technologist all the possibilities of behavior of the sets. It simplifies the technologist understanding the links between the modeled modules, their interaction and complexity of their management [2].

Modules can simulate the processes separately, but also all three modules together. The outputs of one module can be input for other modules. Admission requirements to individual modules from outside can enter several alternatives, but also through individual inputs outsourcer [3].

Fig. 2 Links between individual modules

B. Marshalling Yard

Marshalling yard is an important hub in the process of rail transport. Marshalling yard simulation model allows users to choose from several standard configurations each track groups. For approximation in marshalling yard are activities and especially dimensioning of each source. The model also allows simulate several variants of technological processes [1]. These options give the technologist and users a comprehensive view of all the factors of individual capacities and processes of marshalling yard.

Allows the technologist to choose:

- Standard configuration of rail groups (serial or parallel),
- Number of tracks in each group (reception tracks, sorting tracks, departure tracks, secondary sorting tracks).

The main part of specifying configuration parameters yard is completed with a choice:

- Configuration from a predefined set of rail groups,
- Method of sorting wagons.

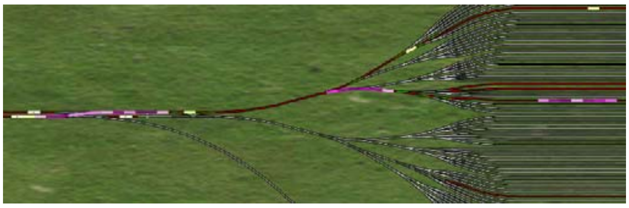

Fig. 3 Sorting in marshalling yard (parallel layout)

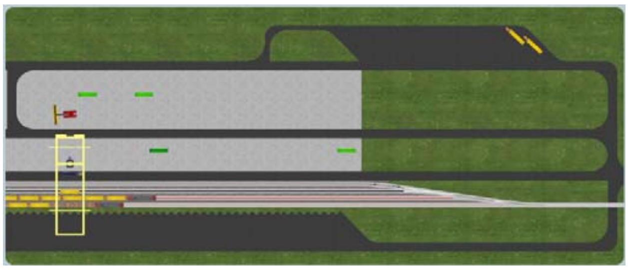

Fig. 4 The container terminal with portal cranes

Input parameter flows are presented by the cars which are transported by in trains. Every wagon, including pallets stored therein, shall be defined destination. Output flows are presented by the outgoing train sets which are formed by the need to (enough number of wagons - the collection of standard) or on a timetable (scheduled requirement) [4].

C. Intermodal Terminal

The intermodal terminal provides a basic preview of the infrastructure and processes in terminal. The model allows technologist to choose between two basic types of internal infrastructure, with defined handling tools [3]:

- The 1st category terminal – rail mounted gantry crane with above and reach stacker with above spreader,
- The 2nd category terminal – reach stacker or side stacker with above spreader.

Each configuration of intermodal terminal contains the one transshipment module with the following parameters:

- The number of rail tracks for trains,
- The number of lines on the road and parking lots for trucks,
- Capacity of storage area (containers, semitrailers),
- Input flow (by road/rail transport),
- Output flow (by road/rail transport).

Input parameters flows represent containers and semi-trailers which are loaded on the wagon, then a truck with a container or truck with semitrailer. Output flows represents the requirements for delivery of containers and semi-trailers. Requirement occurs randomly or according to a fixed time (planned requirement for delivery) [3].

D. Warehouse

Storage is the inseparable part of every logistics system. Warehouse is the object or area specifically designed and intended for the storage of goods, which is equipped with storage technology and equipment intended for the reception, storage, handling, repair and distribution of goods [8].

The modeled warehouse allows create links between railway and road transport.

The technologist has a choice of two basic types of infrastructure, with defined handling tools:

- Type 1 – warehouse with forklift truck or forklift supported,
- Type 2 – warehouse with vehicles with thrust and twist fork or stacker. The layout of warehouse is defined on the basis of selected type of handling equipment with a specified minimum building module.

Input parameters flow is presented by the palettes that can be loaded in sets of railway wagons or with pallets loaded in the road vehicle, or stored in a container.

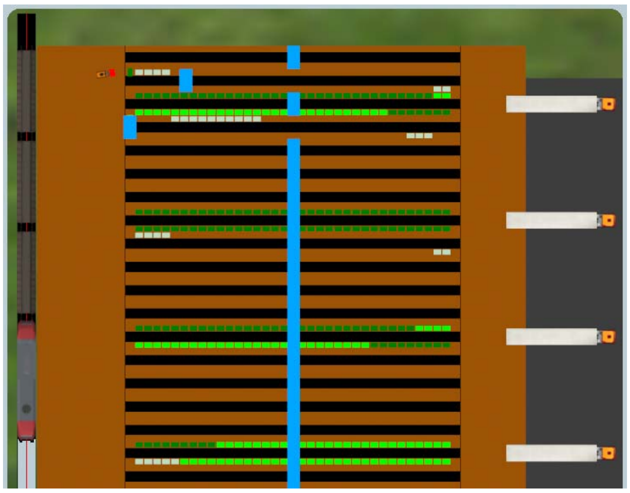

Fig. 5 Warehouse with pallet stacker layout

Consequently, defined parameters of warehouse are experimentally validated for their ability to store up requests coming in the input stream.

E. Results

Evaluation of simulation belongs to the final steps for the simulation run was carried. A technologist evaluates all the set elements in the simulation and interprets individual obtained results. He/she evaluates adequately all the set parameters of simulation with all restrictions. Technologist also thinks of possibilities to the implementation of a simulation run [7].

Most of the ongoing processes are 2D or 3D animated according to the input data to the system and runs through the portrayal of a particular infrastructure hub.

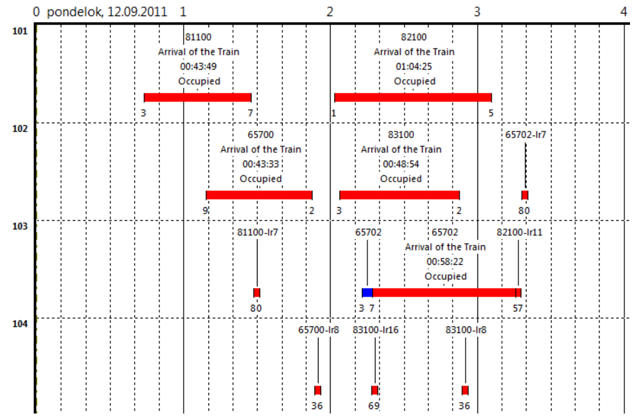

Fig. 6 Results as graphical representation (reception track in marshalling yard)

Therefore, during the simulation collects and stores a lot of information about the behavior of the system. After completion of the simulation, the user has the opportunity to view these collected information in the form of clear graphs and tables. Based on these graphs and tables can analyze the simulation results. This ultimately supports the finding of the final decision [1].

Table | Timeline

Name	Free	Reserved	Occupied
Summary			
Time	39 day(s) 23:40:23	00:06:58	2 day(s) 00:12:38
Time in %	95,21 %	0,01 %	4,78 %
Minimal	00:00:00	00:00:00	00:02:22
Maximal	3 day(s) 00:00:00	00:04:05	01:18:05
101			
Time	2 day(s) 02:17:09	00:00:00	21:42:50
Time in %	69,84 %	0,00 %	30,16 %
Minimal	00:00:00	00:00:00	00:02:29
Maximal	10:14:41	00:00:00	01:17:17

Fig. 7 Results as table representation (reception track in marshalling yard)

IV. Formation of a Simulation Model

The typical project for creation a simulation consists of four main steps:

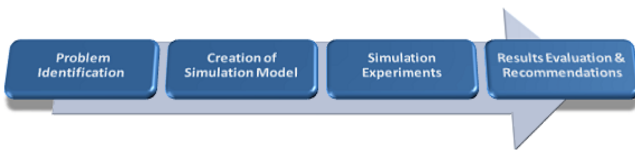

Fig. 8 The steps of simulation project

A. Problem Identification

Very important point for the success of each simulation study is the accurate identification of problems to be solved and precise specification of questions that have to be answered. This is the goal to demarcate primary aim for technologist. Among the tasks that technologist are examining can be listed:

- Verification of the effectiveness changes to the infrastructure and evaluation;
- Throughput capacity investigation in marshalling yards;
- Rationalization of technological procedures in transport terminals;
- Identification of bottlenecks and their elimination;
- Determining an optimal number of vehicles for a handling;
- Verification of gains after modernization of technical equipment;
- Determining optimal number of locomotives and human resources;
- Verification of personnel work shifts scheduling.

B. Creation of Simulation Model – Supplement Its Own Data

The examined system is replaced by its simulation model in order to conduct experiments without influencing the normal operation of the modelled system. Keeping in mind that the goals of the simulation study have to be reached, the simulation model has to be valid and has to model all important aspects of the operation at required level of detail. It is very important that technologist understand the technology processes of the system to the uttermost details

Therefore, close cooperation with the customer and visit(s) to the modelled facility (if existent) is indispensable at this stage [7].

C. Simulation Experiments

Experimenting with the simulation model is an iterative process of consequent runs of simulation with modified parameters with the objective to disclose the behaviour of the system (with the given set of parameters) leading to the solution of a problem [2].

In general, single simulation experiment provides an answer to a single question (e.g. what is the optimal number of sidings in a station). Within the frame of a single simulation experiment many simulation runs with modified parameters (e.g. trying a different number of sidings) are run and evaluated. Correct evaluation of simulation runs shows the direction and next steps in the quest for the solution. [8]

D. Evaluation of the Results

Evaluation of the results includes a detailed analysis of all conducted experiments, answer to questions asked, solutions and recommendations as well as a short management summary of the results and recommendations.

V. The Risks That Affect Overall Simulation Results

A. The Simplification in the Simulation Model

During the construction of simulation model is necessary to make simplifications of the model. These relate in particular to operational situations, which are modeled in a logistics center does not detailed documentation (selected types of commodities transported with specific characteristics).

In introducing the simplification of the technology is the always a problem [4]. On the one hand user wants order to simulation model as similar as possible to the real system. On the other hand, however realizes that given the short time that has to find the optimal solution of a particular project. In the simulation model is necessary earmark a site that simplification does not affect the final results. Simplification is often necessary to apply in situations which are deals with operational logistics center [6].

B. The Cooperation with Programmers

Like all software, as well as the simulation tool is still in development. Some new project can bring a new situation which has not been simulated yet. In this case it is necessary to add a new program module. In such a case at the beginning of work on the programming software discussion takes place, which parties are on the one hand, programmers and technologists on the other [5]. Underestimating the importance of this discussion could make problems and delays in the preparation and evaluation of simulation runs.

It is necessary to remember that very few of programmers have specialized education in the field of transportation technology. Similarly, very few transport technologists has given their education sufficient idea of what they require programming processes of transport. The main responsibility for the successful management of the new requirements for programming and simulation tool required processes, lies on the technologist [7]. He should not neglect the detailed explanation of the processes that the programmer to program. It is more than appropriate when the programmer and technologist cooperate in verifying the correct operation of innovations in software [6].

VI. Conclusion

Planning and optimization of infrastructure logistics centers cannot be done without a detailed and objective assessment of the consequences of the decisions. Adequacy of envisaged interventions in infrastructure and technology to conduct cannot objectively assess without a detailed study of the operation of the center of the planned intervention. For reasons of big complexity of logistics centers and traffic in them is perhaps the only effective technique of examining the consequences of decisions by experimenting on a sufficiently faithful simulation model. Simulation is not “a magic box” in which the issue is placed and from which comes as a result of clear and the best solution to the problem.

The first and the last person who is creating the simulation, experimentation, and the evaluation was, is, and will be always the technologist. He knows all the elements in detail to describe, interpret and subsequently evaluated.

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