COMPUTER SIMULATION OF FREIGHT TRAIN FORMATION IN BRATISLAVA VÝCHOD MARSHALLING YARD

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Abstract. Freight train formation is one of the most complicated and the most expensive process of railway transport. Its optimization and cost reduction is aim of research project called “Examination of application possibility of simultaneous sorting methods in Slovak marshalling yards”. Development of simulation model of Bratislava východ marshalling yard is beginning of first phase of mentioned project. For building of simulation model will be used simulation software Villon.

1. INTRODUCTION
In September 2006 began building of simulation model of Bratislava východ marshalling yard. The simulation model will help to find answers to several questions. The most important question is, “Is it possible to apply the simultaneous sorting methods in formation process of local freight train in Bratislava východ marshalling yard?”

The simulation model will simulate current operation (basic model) and operation with applied simultaneous sorting methods (model with experiment) of Bratislava východ marshalling yard. Principles of simultaneous sorting methods are explained in [3], [4], [5] and [6]. Results of both simulation models will be compared. Thanks comparison of results of both models will be possible to answer asked questions.

2. DESCRIPTION OF BRATISLAVA VÝCHOD MARSHALLING YARD
Bratislava východ marshalling yard is situated in railway junction of capital of Slovak republic. Thanks sophisticated system of connection lines is marshalling yard able to receive freight trains from European railway corridors IV. and V. and other regional lines.

Marshalling yard in current location was opened in 1872. Marshalling yard was modernized in two phases, during 1963-69 and 1974-81. Large reception group (R), classification group (C) and two departure groups (D) were built within the modernization. Layout of siding groups is shown on figure 1.
Hump yard is equipped with GAC-ARS controlling and automation system. Reception group is with hump connected through two feed tracks and one hump track. Thanks connection lines arrive all trains to reception group only from one direction.

Fig. 1. Layout of Bratislava východ marshalling yard

3. USAGE OF SIMULATION TECHNIQUES

Simulation presents technique that supports analysis, proposal and optimization of real systems in following steps:
1. Real system substitution by its simulation model;
2. Experimenting with the simulation model through discovering of its properties, behavior and reaction to different conditions;
3. Application of obtained results to the real system (existing or planned).

Simulation model should be as true to the modeled system as possible. However, a modeling detail limit exists and it should not be exceeded.

A simulation software Villon will be used to simulate the marshalling yard operation. The simulation tool Villon has been developed since 1994. It is result of the cooperation of University of Žilina, Faculty of Management Science and Informatics and SIMCON Ltd. Žilina. Up to now the simulation models of many marshalling yards were built with help of Villon. We can mention especially the following marshalling yards: Wien Zvbf, Linz Ost Vbf, Hamburg Alte Süderelbe, Basel SBB RB I and Lausanne Triage. Experts from Austria, Germany [7], Switzerland [2] and China did measure already qualities and properties of Villon.

Villon enables to create the simulation model that substitutes real existing marshalling yard by computer model. Villon is able to display the marshalling yard very truly and to animate all processes that run in modeled system. Modeled processes run by exactly defined handling technologies. Outputs of Villon are so clear and convincing that they can be used like fair decision support [7].

Work with Villon can be divided to these basic phases:
1. Collection, processing and analyzing of station data;
2. Infrastructure model creation;
3. Creation of dynamic model of operation that is utilized for examinations of station properties and behavior with the proposed traffic variant;
4. *Experimenting* with the simulation model. It is an iterative process of simulation runs with modified parameters so that it leads to a solution of given problems. It is obvious that to find the answer to given question, it is necessary to realize many simulation runs. Their number depends on experimenter’s knowledge, simulation model quality, but also on tools for evaluations of results of realized runs.

5. *Analysis of experiments results* produced by the simulation model. During the simulation run, movement of all mobile elements is animated and technological procedures progress is shown on the screen. Besides the animation, user is able to gain detailed information about all objects in the simulation (trains, tracks, resources, etc.)

Credibility of experiment results depends on infrastructure model verity and on verity of operation performed on this infrastructure. More detailed description of infrastructure and operation models was given in [1].

4. DESIGN OF EXAMINATION PROCESS

Examination of the possibility to apply the simultaneous sorting methods in Bratislava východ marshalling yard will be executed in two phases. Firstly, an effect of application of the simultaneous methods will be examined by using of the preserved number of the composed local freight train. After this analysis will be examined an effect of application of the simultaneous methods by a concentration of the train formation within the new defined part of railway network operated by Bratislava východ marshalling yard and related increase in composed local freight trains. In any case, this examination contains analysis of:

− different sources and input data about the marshalling yard,
− pattern of the train formation processes in the marshalling yard,
− relations with other marshalling yards in the railway network.

Firstly, data about the relations created in marshalling yard should be analyzed. List and scope of relations are available in operating instructions to valid timetable – “Train formation plan” valid for the whole railway network and “Procedure of technological processes of station” that is elaborated and valid for Bratislava východ marshalling yard only. In frame of this analysis it is necessary to observe an actual arrangement of the local freight trains, a number of the operated line segments, an operation frequency (once a day, twice a day) and scheduled departure times of trains. Concerning the agreed operation times in operated stations it is possible to predict that the scheduled departure time is really met. Thanks this it is not necessary to regard an unstableness of the freight railway transport that could make the examination more difficult. In frame of this analysis it is very important to compare departure times of all composed local freight trains. It is possible to ponder on the simultaneous train formation of these trains without changes in the marshalling yard operation plan, if all composed trains departure from the marshalling yard throughout an interval between half an hour and two hours. After this analysis it should be clear if application of the simultaneous methods is effective by the current scope of the local freight trains formation. It is necessary to observe what happens when the departure time is shifted to one time interval if the simultaneous methods can be effectively applied but the trains do not depart in same time interval. The change of the departure time could affect the train formation process of other trains (e.g. conflicts in need of shunting locomotive, personnel or sorting and feed sidings). The change of the operation times in the operated transport will result from the change of the departure time too. Therefore it is necessary to consult it by customers.
In second phase will be designed and executed the concentration of the train formation within the defined future part of railway network operated by Bratislava východ marshalling yard. In this phase possibility of a relocation of the train formation from some small marshalling yards to Bratislava východ marshalling yard will be observed. It can bring better usage of the technical equipment in Bratislava východ marshalling yards and savings in the whole process of the train formation in West Slovakia. It is necessary to define which other local freight trains could be composed in Bratislava východ marshalling yard in this case. Primary criterion for selection of other trains is time that is required to reach last operated station on line segment. This time include running time and operation time in passed stations.

5. CONCLUSIONS

The operation of the marshalling yard and its optimization cannot be done without detailed and objective examination of effects of taken decisions. Suitability of planned changes in operation plan cannot be objectively examined without detailed observation of marshalling yard operation after planned change. Due to the high level of operation complexity at marshalling yards, simulation may be the only efficient technique to examine the consequences of taken decisions.

5. REFERENCES


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