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OPERATIONAL PLANNING OF RAILWAY TRANSPORT IN CRISIS SITUATIONS IN CASE OF SLOVAKIA AND SERBIA

Zdeněk Dvořák, Zoran Čekerevac, Ivo Milata
Zdenek.Dvorak@fsi.uniza.sk, Zoran_Cekerevac@hotmail.com, Ivo.Milata@fsi.uniza.sk

University of Zilina and Union University Belgrade
SLOVAKIA *and* SERBIA

Abstract: *The paper describes issues connected to theoretical assumptions for the operational planning of rail transport. It also deals with mathematical model of planning in rail transport as well as it describes draft software, which is solving operational planning of rail transport.*
Key words:
Operational planning, railway transport, crisis situations

INTRODUCTION

In the years 2008 and 2009 there existed common Slovak - Serbian bilateral project entitled - Operational planning of railway transport in crisis situations. Authors are publishing the conclusions of the project in this paper which are dedicated for a major international conference.

THEORETICAL FOREWORD

At the beginning of the 21st century, the rail transport is crucial amongst the used transport means. In comparison with other transport means, in cases of crisis situations and their solutions, rail transport has many advantages:

- It has high transport capacity;
- It is suitable for public transport and material transport on medium and large distances,
- It reaches high sector speed,
- It is highly reliable; it does not depend on day time or weather.

The experience shows that in cases of crisis situations of wide ranges, when the road transport was passed away or its capacity was low, the railways were working without limits. Especially in cases of huge evacuations the rail transport was the most important transport mean.

MODERN STATUE OF USING RAILWAY TRANSPORT

Crisis situations in transport infrastructure can cause violation or abortion of transport. In cases of transport infrastructure violation the transport can be started immediately. In cases of transport abortion, the renewal has to be proceeded to provide basic transport capacity. In both cases the transport could be done in limited range according to not usual organisation.

In present time there is a plan for preparing a number of actions focused on transport route renewal which should help in removing negative aspects in railway transport. Unfortunately, there exists no unique method, aimed on providing required transport capacity by effective way in conditions of limited transport capacity, which could create functional technology for railway transport.

Due to mentioned facts and issues, common Slovak and Serbian project realised the following actions:

- Elaboration and application of modern management methods on chosen problems;
- Theoretical investigation in the area of interest based on testing by the computer program ASTRA as well as it's practical usage in cases of crisis situations;

- Defining of management algorithms for managing of railway transport in limited conditions;
- Testing of possible evaluations of transport situation on route sector or whole route;
- Creating of general theory as a base for future research and solution finding for transport technology problems in crisis situations;
- Creating of the crisis train diagram of railway transport.

Basic solution of problem is graphically shown on Fig. 1.

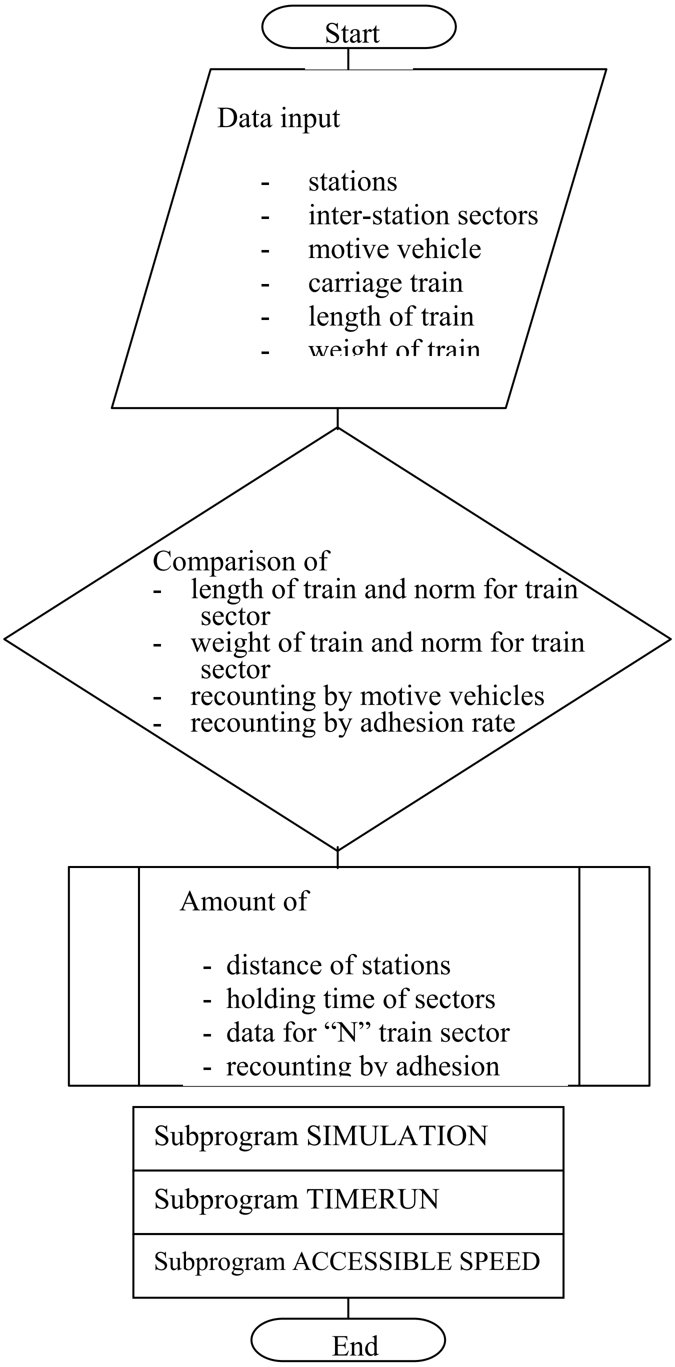

Fig. 1 Flow chart - of problem solving algorithms

The international cooperation was very helpful in solving mentioned problems, mainly in generalizing gained knowledge and skills.

PRACTICAL SOLUTION USING OF THE COMPUTER PROGRAM ASTRA

This article will show visual windows from Slovak version of Astra computer program. First window with an icon of locomotive vehicle was focused on calculation tasks and actualisation of databases.

Fig. 2 The first window of ASTRA programme

The input of data is preceded through the roll bars. Roll bar TRAT (ROUTE) – gives a possibility to choose from any railway route that operate by Railways of the Slovak Republic (ZSR) The roll bar motive vehicle offers all possible vehicles for selected route.

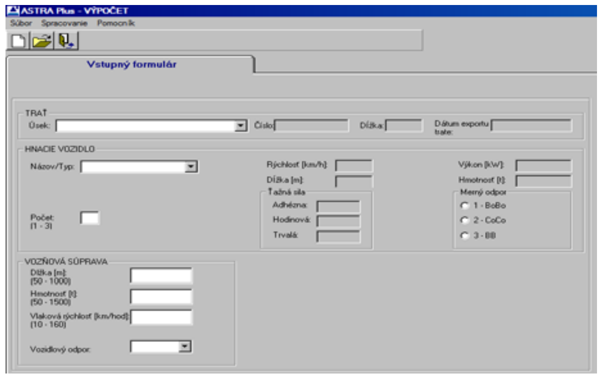

Fig. 3 Window for data input

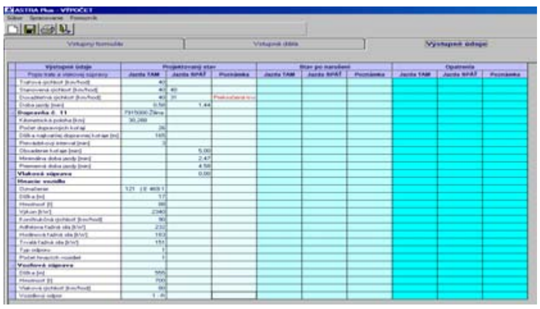

Fig. 4 Window showing real data in database

After data input phase all data were rewritten into databases (Fig. 4).

The work and proceeding of real data was very important part of the project. Problematic objects were shown in red colour in output window.

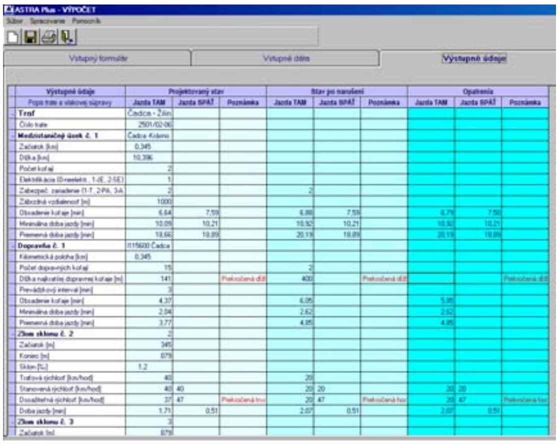

Fig. 5 Window output data

For everyday work in transport railway companies to bring new technical or technological solutions it is needed to focus attention on these objects.

GRAPHICAL SIMULATION IN ASTRA PROGRAM

Graphical visualisation is based on displaying of calculated values of simulation in form of agreed signs in real time according to selected time scale. The stations of simulation model are displayed by graphical signs on monitor in dependence to their position on selected scale. The trains are displayed by black spots according to time and location.

Displaying consists from:

- Static objects as stations, tracks, station rails, security systems characterised by their location and distance in kilometres, state and number of tracks,
- Dynamical objects such as train sets which are characterised by location and speed.

Displaying is proceeded in:

- Moments of timer violation (violation of timer is done in given time intervals, which can be changed during simulation).
- Moment, when new requirement (train) enters the simulation model.

Displaying of graphical simulation is shown on figure 6. This simulation is preceded in real time with focus on technological solution of problem object.

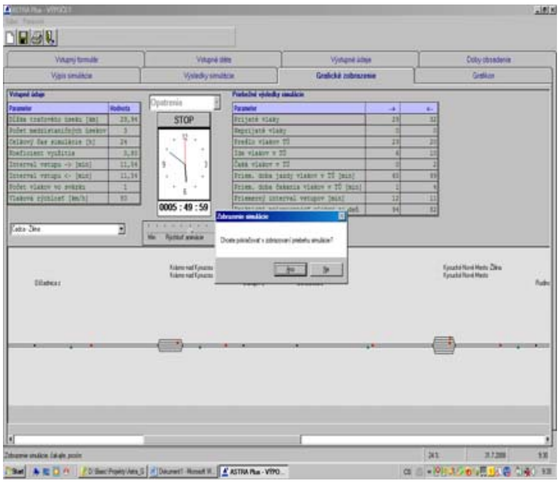

Fig.6 Window of graphical simulation

Other real output of simulation is overview table, which displays all needed data, figure 7.

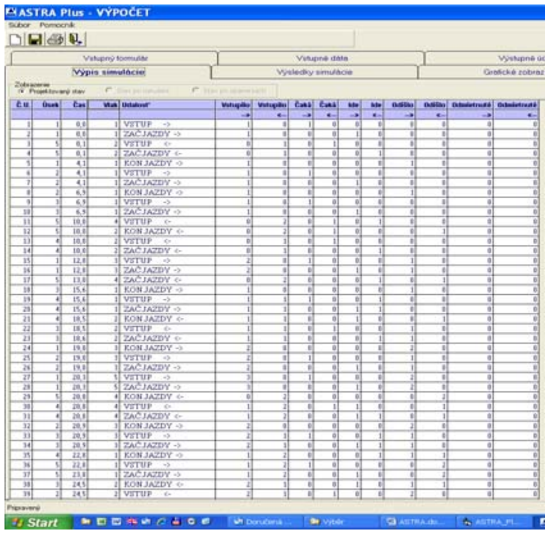

Fig. 7 Listing of simulation

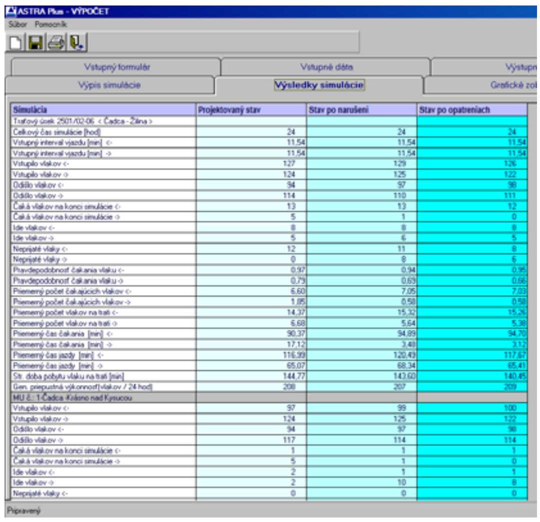

Fig. 8 Results of simulation

Due to the fact, that detailed list of all results was too huge for practical usage by experts in field, programmers of ASTRA decided to create summary output of simulation results – look at figure 8. This window is designed to evaluate projected state, state after violation and state after application of measures.

PREVIEW OF PROJECT RESULTS

The railway transport in route sectors is possible to understand as bulk service system and it considers railway route as a service line. It is a system, which is also well-known as M/M/1, where there are no limits in requirements, stations of services are limited (in our case it is one service station) and waiting for service requirements. Service requirements are trains entering route segment. Service time is time, when the trains are occupying route rail – as at figure 9.

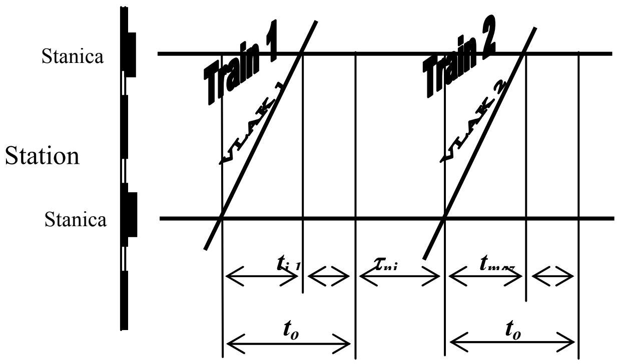

Fig. 9 Train operating time

Legend:

- $t_{j,1}$ - time of train journey through route sector,
- τ_{nj} - time interval, after which next train journey can be done,
- t_{mez} - time gap before journey of next train,
- $t_{obs,1}$ - time of route sector occupancy by first train.

The simulation of traffic in railway route sectors depends on three parameters:

- Time interval of train entrance to the route sector - t_i,
- Time of route sector occupancy - t_{obs},
- Number of route and station tracks, on which the traffic will be done and can be possibly used for waiting of trains.

Incoming current of requirements – trains is originating in train generating stations on direction tracks. Generated trains are waiting for departure in outgoing set of tracks where they can create queue. The tracks in selected train stations are used for train journey, but they can be also used for train stopping while waiting. Due to the limitation of track number there are also limits for queue – number of trains waiting.

It is not possible to prepare the train transport diagram with consideration of floating displayed actions (train journey, station intervals, train and station measures and action etc.). Time needed for these actions has to be constant. Duration of train passing the same route sector has to be planned as fixed, despite the fact it is not like this.

The fact is that the program ASTRA+ does not offer constant time duration of activities, so it will be essential to add this function. The main problem is which value should be used. Erlang's distribution is sidelong to the right.

The dilemma was whether we should use average of generated values, or median of maximal and minimal generated vale.

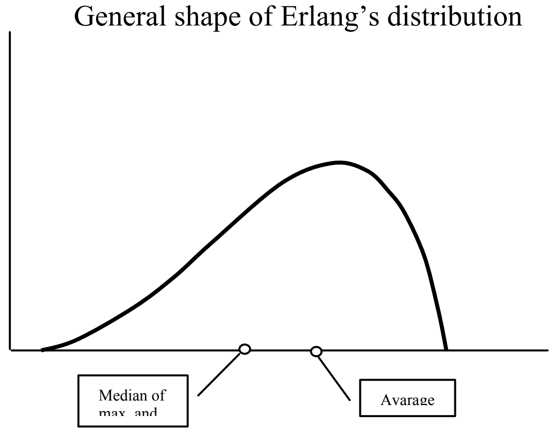

Fig. 10 Possible Erlang's distribution

The calculation of parameters in Erlang's distribution from maximal, minimal and mean value of duration was done according to these relations.

$$Sigma = \frac{\max - \min}{6} \qquad [1]$$

$$A = Int\frac{stred^2}{Sima^2} + 0.5 \qquad [2]$$

$$B = \frac{A}{stred} \qquad [3]$$

$$Y0 = \min \qquad [4]$$

Testing was performed on 50 files, which consisted from 500 items, what finally resulted 25 000 of simulations.

The test has proven that train diagram can be transferred into a program with extremely low deviations, if the average of generated values is used.

After announcing of one of the crisis states, the Railways of Slovak Republic can organize railway transport according to "crisis train diagram of railway transport". This train diagram is based on "list of passenger trains for crisis situation period"

CONCLUSION

In praxis in railway network there could appear some situations when, compared to usual state, some limitations in the transport capacities on certain sectors appear. Organisation of the railway transport in this segment is crucial for the transport capacity of the whole route. The methods of management work are in this case totally different from the usual methods.

The analyses and results of the international project made us sure that there is a huge number of scientific problems and that it is really essential to work on their solutions on international level. By this way we would like to thank to all people who have been a part of solving teams in Slovakia and in Serbia.

LITERATURE:

[1] Linda, B., Fronc,M., 1986: *Operačná analýza 4*. Alfa Bratislava 1986,

[2] Máca, J. – Leitner, B. *Multikriteriálna optimalizácia rozhodovania pri krízovom riadení.* Zborník vedeckej konferencie "Riešenie krízových situácií v špecifickom prostredí" – II. časť, FŠI ŽU, Žilina 2002, str. 271-278, ISBN 80-88829–71-2

[3] Máca, J. – Leitner, B.: *Operačná analýza pre bezpečnostný manažment*, Fakulta špeciálneho inžinierstva ŽU, Košice 2002. 181 s. ISBN 80 – 88829 – 39 – 9

[4] Milata, I. *Teorie hromadné obsluhy ve vojenské dopravě,* Skriptum, Vojenská fakulta VŠDS. Žilina 1992

[5] Milata, I., Kašpar, V., Rošteková, L., Dvořák, Z., 2004.: *Mathematical support of crisis planning*. In: Komunikace, vedecké listy Žilinskej univerzity, ročník 3/2005, s. 64 - 68, ISSN 1335-4204.

[6] Novák, L., Milata, I.: *Application of „3 sigma theory" to Erlangs distribution of random variable.* In: Zborník z X. International Scientific Conference TEMPT´97. Bulharsko, Sofia, Higher Military School of Transport, 1996

[7] Soušek, R.: *Krizové řízení v dopravě*. Institut Jana Pernera, o.p.s 2002, Pardubice. ISBN 978-80-86530-06-27

[8] Sventeková, E., 2004.: *Riziková analýza v dopravných systémoch*, In: Zborník z vedeckej konferencie s medzinárodnou účasťou LOGI 2005, Pardubice, Univerzita Pardubice, str. 219-223, ISBN 80-86530-25-6

[9] Sventeková, E., 2006: *Zásady zvyšovania bezpečnosti na dopravných cestách*, In: Zborník príspevkov z medzinárodnej konferencie Požární ochrana 2006, Ostrava, VŠB-TU Ostrava, str. 394-399, ISBN 80-86634-88-4

[10] Davidovic B, Čekerevac Z, *Integration of the System for Providing Quality and Controlling Into Logistic Processes*, in proc. Fifteenth International Scientific Conference Transport 2005, November 11 - 12, 2005, Sofia, Bulgaria, 2005.

[11] Letić D, Davidović B, Čekerevac Z, Dvorak Z, Berković I, Kazi Lj, Desnica E, *Operations Research Expositions in MathCAD*, FSI ZUZ, Hydropneutech, Žilina, Slovakia, Mart 2008, ISBN 978-80-968479-4-5

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ЕКСПЛОАТАЦИОННО ПЛАНИРАНЕ НА ЖЕЛЕЗОПЪТНИЯ ТРАНСПОРТ В КРИЗИСНИ СИТУАЦИИ В СЛОВАКИЯ И СЪРБИЯ

Зденек Дворак, Зоран Чекеревац, Иво Милата

Zdenek.Dvorak@fsi.uniza.sk Zoran_Cekerevac@hotmail.com Ivo.Milata@fsi.uniza.sk

Университет в Жилина и Съюзен университет в Белград

СЛОВАКИЯ и СЪРБИЯ

Ключови думи: *експлоатационно планиране, железопътен транспорт, кризисни ситуации*

Анотация:*Статията третира въпроси, свързани с теоретически допускания в областта на експлоатационното планиране на железопътния транспорт. Тя също представя математически модел на планиране в железопътния транспорт и описва софтуер за целите на експлоатационното планиране.*