Journal of System Simulation

Volume 32 | Issue 2 Article 22

2-19-2020

Improving the efficiency of transport systems using simulation

Bushuev Sergey

Kovalev Igor

Permikin Vadim

Anashkina Nataliia

Abstract

Abstract: The article describes the possibilities of application of simulation modeling for the analysis of infrastructure and technology of transport services of enterprises. The main technological and possible economic effects for the enterprises arising at performance of modeling of a transport component of their work are resulted.

第 32 卷第 2 期 系统仿真学报© Vol. 32 No. 2
2020 年 2 月 Journal of System Simulation Feb., 2020

Improving the efficiency of transport systems using simulation

Bushuev Sergey Valentinovich, *Kovalev Igor Alexandrovich*,
Permikin Vadim Yurievich, *Anashkina Nataliia Yurievna*

Abstract: The article describes the possibilities of application of simulation modeling for the analysis of infrastructure and technology of transport services of enterprises. The main technological and possible economic effects for the enterprises arising at performance of modeling of a transport component of their work are resulted.

CLC number：U16 Document identification code：A
Article number：1004-731X (2020) 02-0340-06
DOI: 10.16182/j.issn1004731x.joss.19-0682

Introduction

Technological and economic performance of transport facilities directly depend on the technical structure and technology of work, which, in turn, can not change with changing flows. The dynamism of the situation requires decisions on finding rational technical equipment corresponding to the current train and car traffic volume, rational technology of work, as well as assessing the consequences of changes in the structure and technology of the station. Selecting a specific list of technical devices is a complex multivariate task[1-2].

The evaluation of design decisions and the determination of the possibility of transport in the conditions of increasing production volumes can give an understanding of what should be the transport structure and technology for their development. The implementation of such calculations is justified, since the increase in production volumes, as a rule, entails a change in the infrastructure and technology of the transport system of the enterprise[3]. The issues of interaction and mutual influence of transport infrastructure and technology are not reflected in the solutions proposed by design organizations, which often leads to a mismatch of production and transport capabilities at the enterprise. Accurate calculation is very important here. Significant economic damage occurs both in the case of excessive reduction of technical means and in the case of excessive structure[4]. According to expert estimates, the probability of choosing an irrational option without preliminary calculation by the simulation method is up to 75%~80%.

Findings

The simulation model is created on the basis of the scheme with a detailed display of all elements of the structure (tracks, switches, block sections, etc.), their capacity and specialization. The technology of operation

Bushuev Sergey Valentinovich, Ph. D. in Technical Sciences, Associate Professor, USURT;
Kovalev Igor Alexandrovich, Ph. D. in Technical Sciences, Associate Professor, USURT;
Permikin Vadim Yurievich, Ph. D. in Technical Sciences, Associate Professor, USURT;
Anashkina Nataliia Yurievna, Ph. D. in Philology, Associate Professor, USURT.

in the simulation model is described at the level of elementary operations[5]. In general, the technological process is presented in the form of a branched sequence of operations with a set of conditions for their implementation. The technological process allows displaying in detail in the model the control processes, including the conditions of operations, possible options for actions, routes of movement with quantitative and temporal characteristics.

The simulation system of transport simulation allows calculating the following technical and technological parameters of the railway transport system of the enterprise:

1. Technical parameters of the transport system

a. Capacity of marshalling means

b. Number of tracks at stations

c. Number of sea berths

d. The number of locomotives

e. Warehouse capacity

f. Number of cranes and loaders

g. Capacity of cargo devices

h. Other technical parameters

2. Technological parameters of the transport system

a. Actual throughput

b. Processing capacity of devices

c. Capacity of cargo devices

d. Effective storage capacity of warehouses

e. Degree of useful use of devices

f. Residence time of goods at warehouses

g. Automobiles non-running time

h. Cars non-running time

i. Ships non-running time

The system produces and allows to analyze the results of work with accuracy to each element, to each operation. The results of the calculation can be presented in the form of a daily schedule (Fig. 1), in the form of tabular reports, display devices on the diagram, the sequence of all operations and other forms. The graphic form gives the opportunity to provide reliability of modeling results and accuracy of the made decisions. The different size of the calculation period ensures to assess the stability of the work over a long period of time, to experiment with different versions of schedules, to check the influence of random factors[3, 6].

The results of the study allow:

- to check possibilities of existing transport service at increase in production or change of the nomenclature of products;

- to determine the" bottlenecks " of the structure and their impact on production volumes;

- identify factors that destabilize the work and reduce their impact on the transport service of production.

第 32 卷第 2 期　　　系统仿真学报　　　Vol. 32 No. 2
2020 年 2 月　　　Journal of System Simulation　　　Feb., 2020

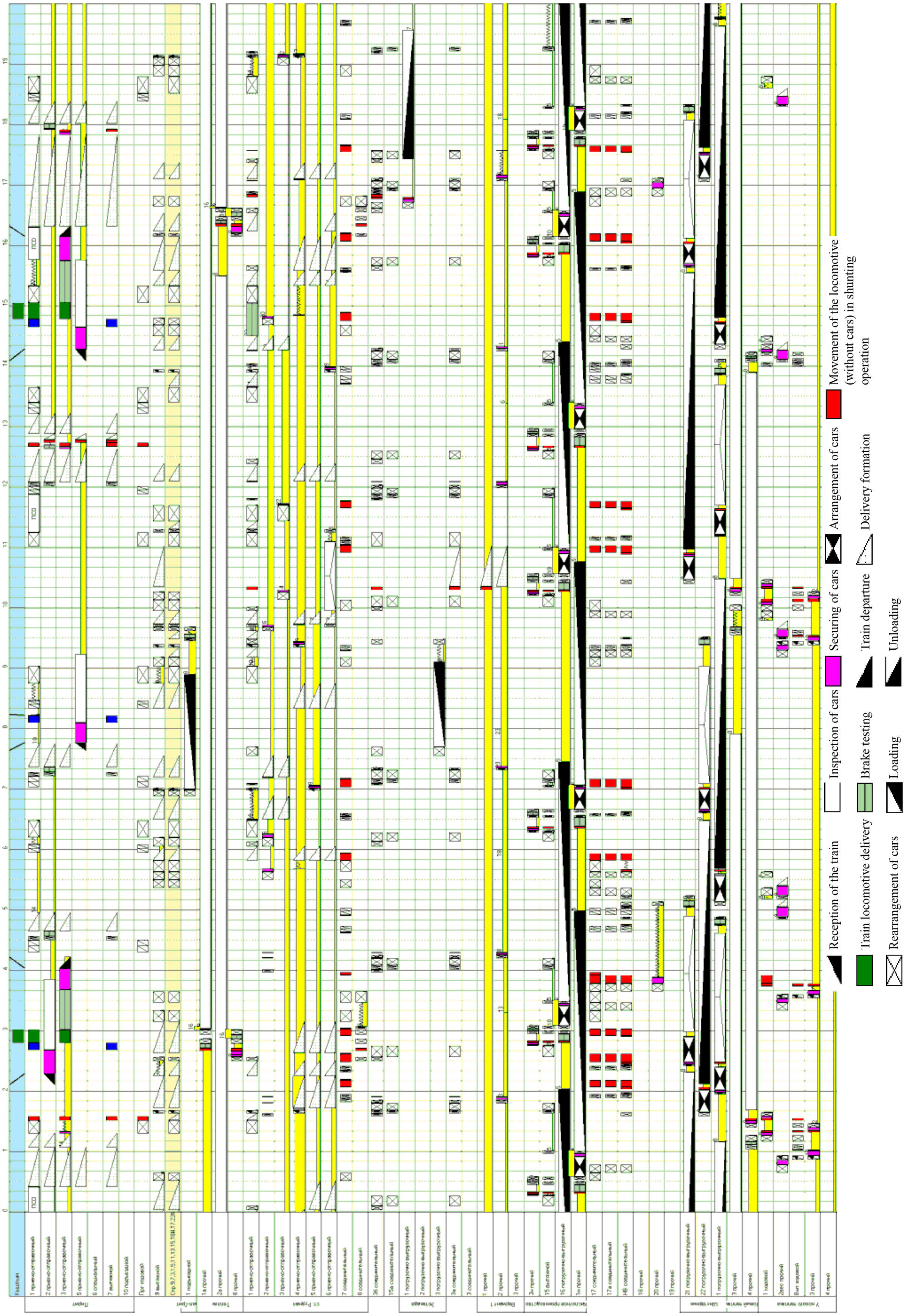

Fig. 1　Graphical representation of the transport system operation

On the basis of this it becomes possible carrying out a phased program for the development of the transport system with an increase in traffic volumes and production. An example of this solution is shown in Fig.2, 3.

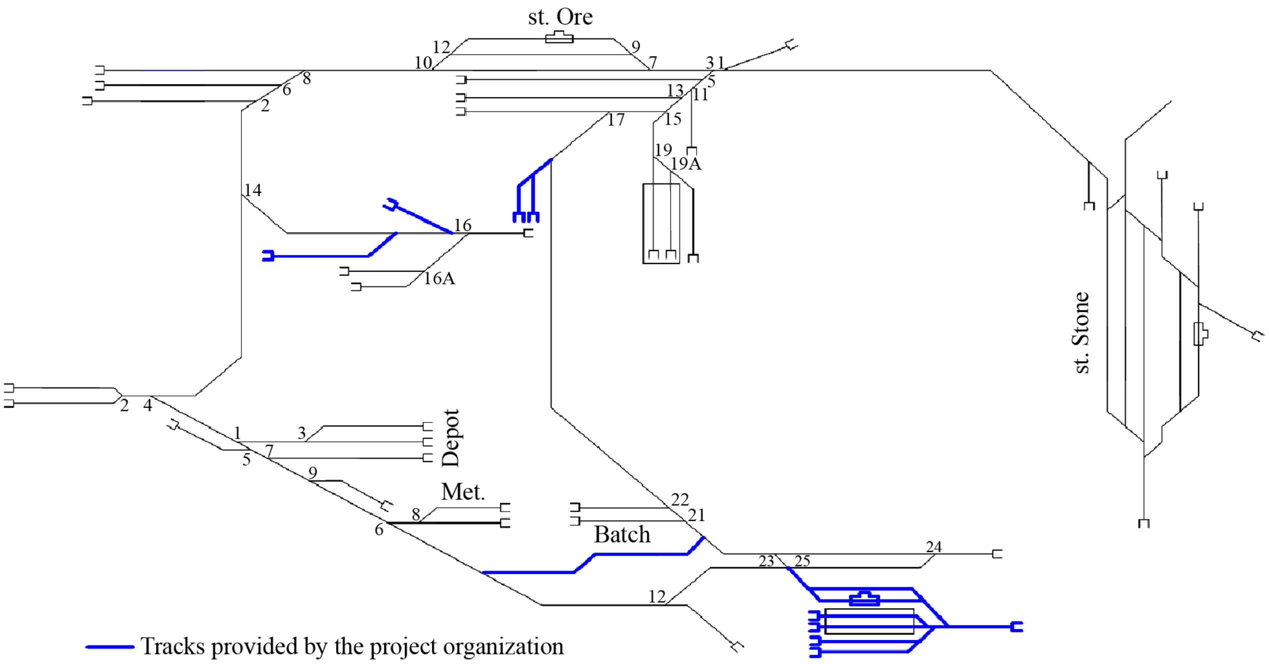

Fig. 2 Infrastructure development at the first stage

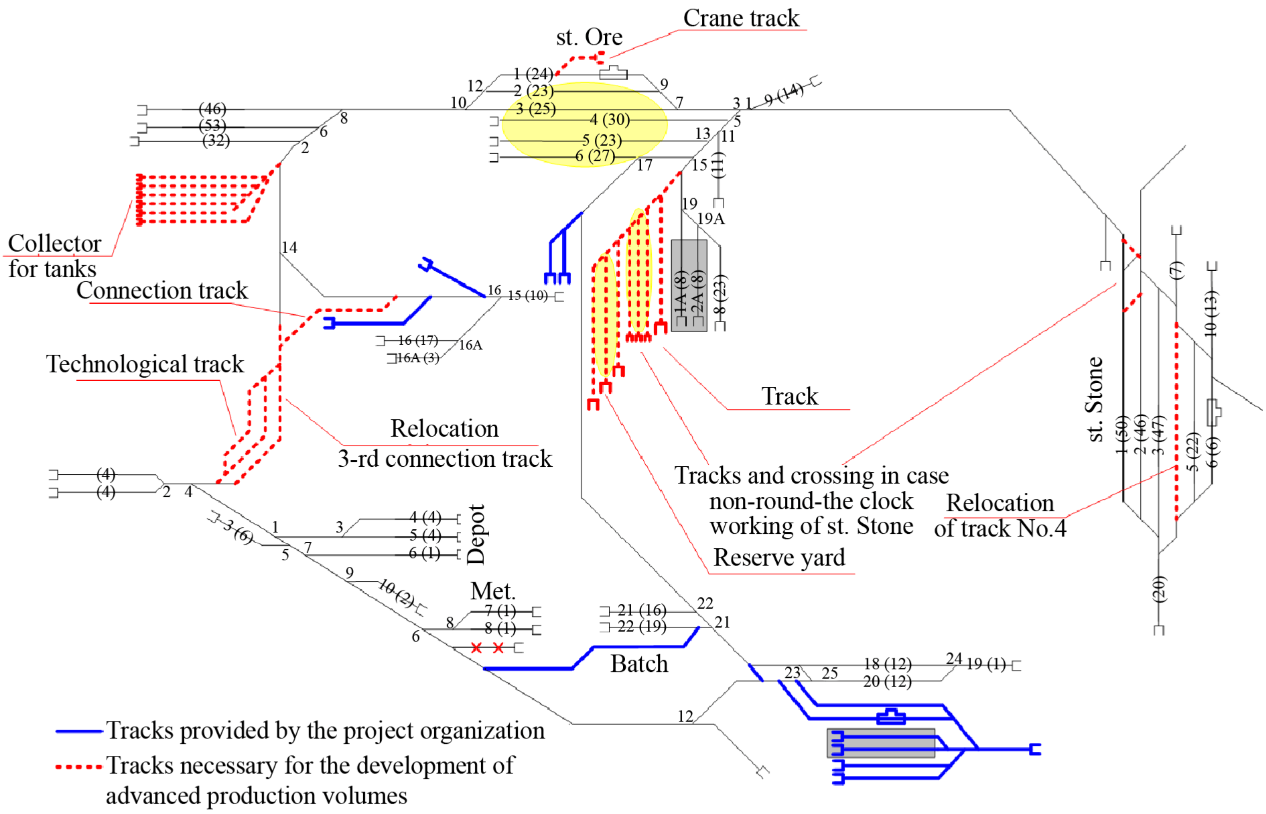

Fig. 3 Infrastructure development at the second stage

https://dc-china-simulation.researchcommons.org/journal/vol32/iss2/22
DOI: 10.16182/j.issn1004731x.joss.19-0682

第 32 卷第 2 期 系统仿真学报 Vol. 32 No. 2
2020 年 2 月 Journal of System Simulation Feb., 2020

The stages of infrastructure development were obtained on the basis of the analysis of variety of design situations. The situations on the model reflect different modes of operation of the enterprise. The main results of calculations for the choice of infrastructure development (Fig. 3, 4) are given in Tab. 1.

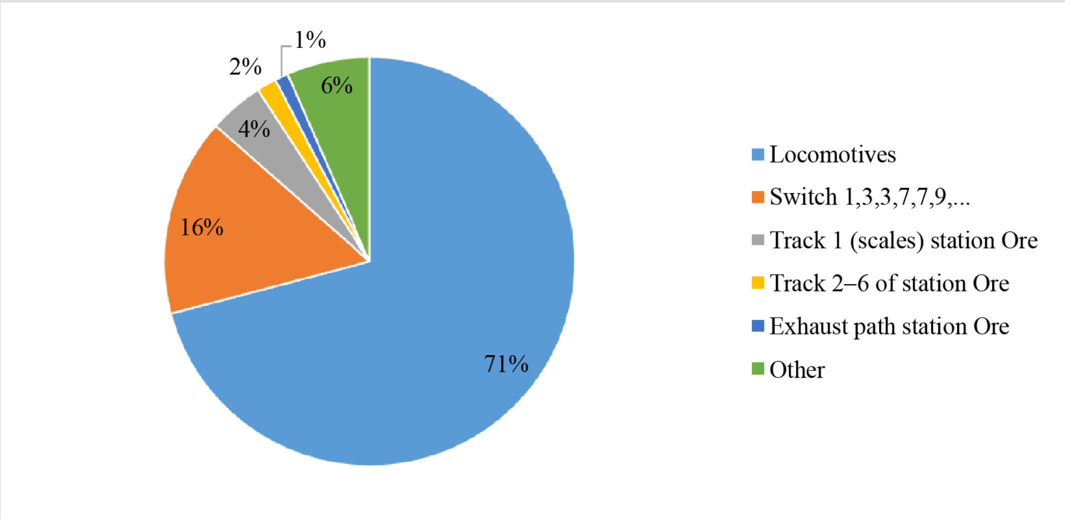

Fig. 4 Distribution of delays due to infrastructure elements

Tab. 1 Calculation Results

The estimated situation			Basic	1	2	3	4
The rest of the cars	The beginning of the calculation		77	106	211	211	211
	The end of the calculation		124	158	228	251	158
The calculation period	Arrived	Trains	4	4	4	4	4
		Cars	115	115	111	145	88
	Departed	Trains	3	3	3	4	4
		Cars	107	139	113	147	165
Cars for defrosting	In line to start		35	35	110	110	110
	Arrived	Total	128	180	122	154	74
		Average/day	25,6	36	24,4	30,8	14,8
	In line for the end		53	118	135	174	75
Delays	Hour/day		6	6	8	10	9
Non-running time	Cars-hour/ day		2700	4 669	5 643	6 200	4 882

For each situation, quantitative and qualitative performance indicators issued by the simulation system during the calculation were evaluated. Fig. 4 shows the total delays due to infrastructure elements in the basic version of Tab. 1.

Another advantage of using the results of simulation modeling is the opportunity to plan the restructuring of production and to carry out the associated assessment of design decisions on the possibility of developing the transport system of promising production volumes (Fig. 5).

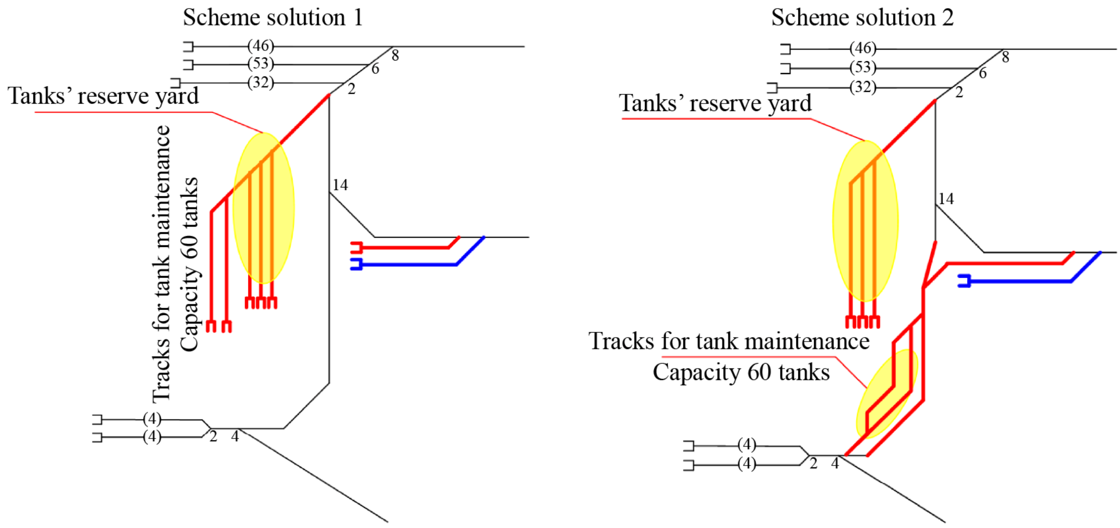

Fig. 5 Schemes of perspective track development

Conclusion

The effect for the enterprise from the examination of the development of transport infrastructure can be achieved by:

- reduction of operating costs with rationalization of technology and technical structure (tracks, switches, locomotives);

- reduction of capital costs and operating costs by eliminating incorrect design decisions in the reconstruction of transport infrastructure;

- adjustment of the investment program, saving capital costs by freeing up funds from the construction of unnecessary infrastructure.

Reference:

[1] Adamko N. Optimisation of railway terminal design and operations using villon generic simulation model[J]. N. Adamko, V. Klima. // Transport, 2008, 23(4): 335-341.

[2] Adamko N. Designing railway terminals using simulation techniques[J]. N. Adamko, V. Klima and P. Marton // International Journal of Civil Engineering, 2010(1): 58-67.

[3] Perovskaya E D I N Kagadi. Study of the system "Cargo station-non-public way" using a simulation model[J]. Scientific problems of transport in Siberia and the Far East, 2015(4): 4-6.

[4] I A Kovalev, V S Kolokolnikov. Comparison of modern methods of calculation of railway stations[J]. Innovative transport, 2015, 1(15): 80-82.

[5] I A Kovalev, V S Kolokolnikov. Application of structural and technological research in planning the development of transport systems of industrial enterprises[J]. Innovative transport, 2015, 4(18): 62-66.

[6] Perovskaya E D I N Kagadi. Simulation of cargo operation of the station in interaction with non-public tracks[J]. News of The TRANS-Siberian, 2016, 1(25): 91-96.

https://dc-china-simulation.researchcommons.org/journal/vol32/iss2/22
DOI: 10.16182/j.issn1004731x.joss.19-0682