SIMULATION – A WAY HOW TO QUANTIFY FREIGHT VILLAGE PERFORMANCE

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Abstract: In Moravian - Silesian country a freight village will be built. VŠB - TU Ostrava has solved a project devoted to this freight village. Concepts of freight villages were created within this project in different locations. A simulation was used for the purpose of the performance determination of the created concepts. This paper describes the simulation model and presents the most important outcomes of simulation experiments.

Keywords: Freight village performance, simulation, Witness

1. Introduction

VŠB - Technical University of Ostrava has solved a project devoted to concept of freight village that will be built in Moravian - Silesian country. This project included primary analyses, firstly analysis of the transport infrastructure of this region, material flow analysis etc. (see in [1.]).
Acceptable locations were chosen on the basis of these analyses. The most suitable locations were ensued from these analyses near Ostrava. The selected locations are:

- Mošnov,
- Bohumín-Vrbice,
- Horní Suchá,
- Stonava.

Structural designs of freight village were projected for these locations. Each design is characterized by a total area of the freight village, transport connections, warehouses area, area designed for containers manipulation etc. We can expect various performances, because the designs of freight villages are not identical. And the problem is how to quantify performances of particular designs. The answer is a simulation.

2. Simulation model of freight village working and reached outcomes

Created model simulates manipulation with containers and pallets from the moment of input to freight village to the moment of output from freight village. It was considered that containers can go into and leave freight village loaded on truck or wagon. Single pallets can enter and leave freight village loaded on truck or can be loaded into / unloaded from containers within freight village. We are able to distinguish three parts of model:

- manipulation with containers for relation road - railway; this part models containers reloading from trucks to wagons, containers storage is included in this part too,
- manipulation with containers for relation railway - road; this part represents containers reloading from wagons to trucks, pallets flow can be generated by pallets unloading from containers within this manipulation,
- manipulation with pallets; this part models pallets reloading from trucks to containers and pallets storage.

The basic structure of model is given below in Fig. 1.

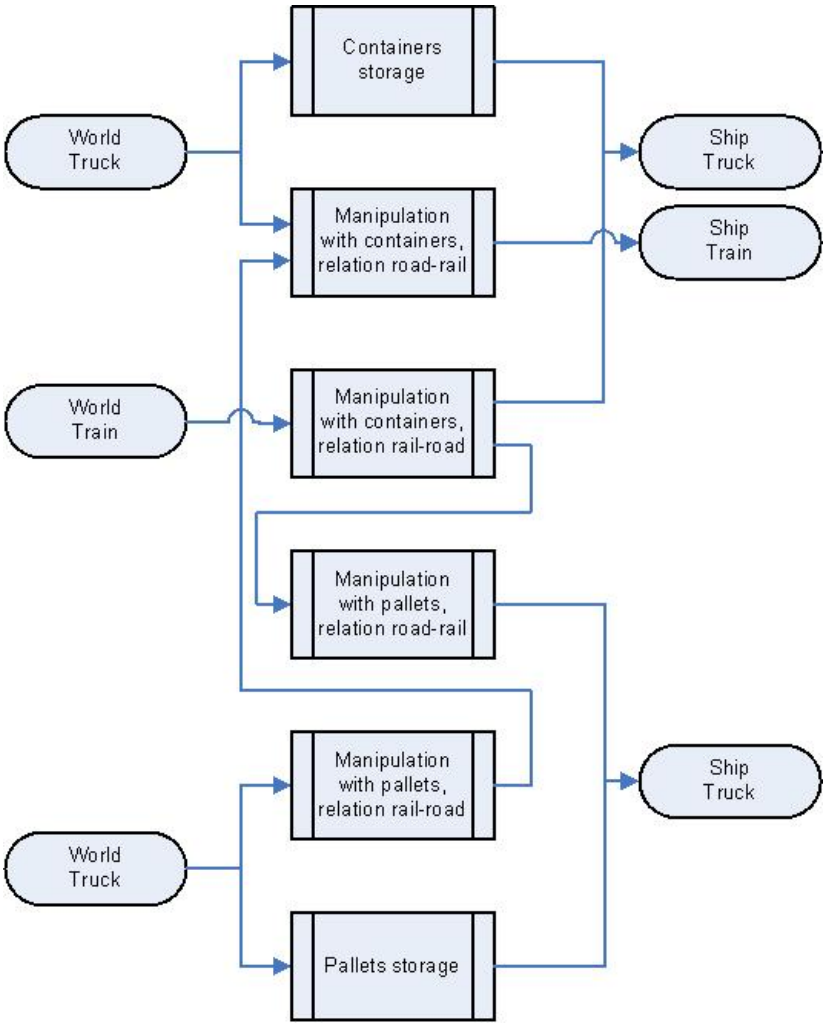

Fig. 1. Basic model structure

Defining aims of freight village simulation were as follows:

- assessment of maximal daily number of trucks entering and leaving the freight village by meeting the conditions as:
  - intended number, capacity and relations of trains operating the freight village,

- intended arrangement of rails stated for loading and unloading,
- defined areas for containers and pallets storage etc.

- assessment of the most important factors having effect on freight village working as:
  - type and number of used manipulation vehicles,
  - disposition of particular manipulation areas etc.

Required simulation outcomes were specified on the basis of defined aims as follows:

- daily number assessment of entering trucks loaded with containers,
- daily number assessment of leaving trucks loaded with containers,
- daily number assessment of entering trucks loaded with pallets,
- daily number assessment of leaving trucks loaded with pallets,
- average daily freight village performance assessment in TEU (Twenty-foot equivalent unit) and pallets.

During the simulation the other values were observed, for example:

- average delay of containers and pallets in freight village,
- filling of storage areas etc.

In Fig. 2. you can see already completed simulation model of the freight village designed for our purposes. This model was created by simulation software Witness.

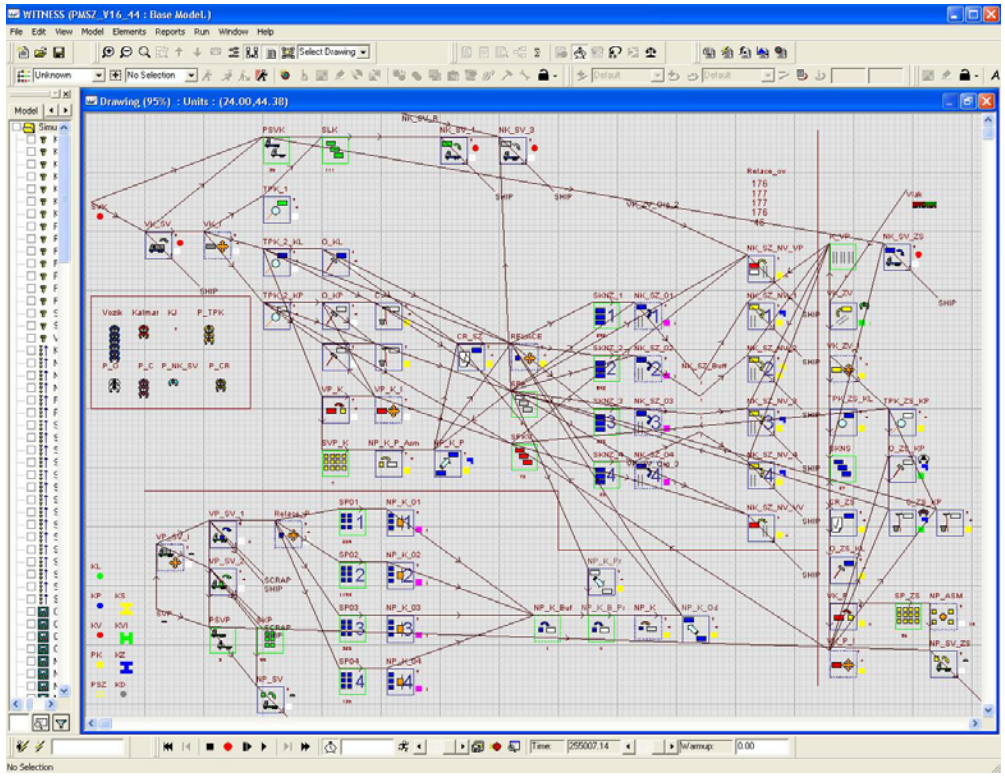

Fig. 2. Created simulation model of freight village working

Three different versions were simulated for each freight village locality differing by configuration of model. These versions were denoted as:

- version I - basic (minimal) version,
- version II - modified (maximal) version,
- version III - version minimizing containers delay.

The first version represents the minimal model configuration. In this configuration freight village basic required functions are able to perform. The second version was simulated for the purpose of maximal daily performance assessment in [TEU]. So we can say that this version corresponds to the maximal possible performance of every locality. The third version represents freight village configuration minimizing average delay of containers in model. Version II and III were obtained by using Witness module named Optimizer. In Table 1. and 2. we can see the basic outcomes of executed simulation experiments. Notice, that all experiments were simulated for 10 years of freight village working.

Table 1. Basic outcomes of simulation experiments

Locality	Version	Average daily number of trucks		Average daily performance in [TEU]		Average annual performance in [TEU]	
Mošnov	I	501,4	Increase [%]	279,0	Increase [%]	101 840,8	Increase [%]
	II	606,8	21,00	360,4	29,17	131 545,6	29,17
	III	501,5	0,02	279,0	0,00	101 844,5	0,00
Bohumín-Vrbice	I	508,8	Increase [%]	278,8	Increase [%]	101 764,9	Increase [%]
	II	611,8	20,24	348,5	24,98	127 189,7	24,98
	III	510,2	0,27	278,8	0,00	101 764,6	0,00
Horní Suchá	I	507,0	Increase [%]	278,8	Increase [%]	101 769,7	Increase [%]
	II	610,3	20,38	349,9	25,51	127 728,1	25,51
	III	507,0	-0,01	278,8	0,00	101 769,7	0,00
Stonava	I	501,5	Increase [%]	278,8	Increase [%]	101 763,5	Increase [%]
	II	597,4	19,11	349,5	25,36	127 569,0	25,36
	III	501,7	0,04	278,8	0,00	101 763,8	0,00

Table 2. Average daily number of couple of trains

	Locality											
	Mošnov			Bohumín-Vrbice			Stonava			Horní Suchá		
	I	II	III	I	II	III	I	II	III	I	II	III
Average daily number of couple of trains	4,26	4,31	4,26	4,25	4,27	4,25	4,25	4,31	4,25	4,24	4,27	4,25
Sort of train												
A	8	8	8	8	8	8	8	8	8	8	8	8
B	0,26	0,31	0,26	0,25	0,27	0,25	0,25	0,31	0,25	0,24	0,27	0,25
C	0,26	0,31	0,26	0,25	0,27	0,25	0,25	0,31	0,25	0,24	0,27	0,25

Sort of train:

A „Trains for relation“ - 70% loaded containers, 30% empty containers.
B 100% empty containers.
C Only empty wagons.

Trains A carry containers for particular relations to and out of the freight village, a percentage ratio of loaded and empty containers was established by authors. Transport of empty defective containers, which can not be repaired inside the freight village, and redundant empty containers out of the freight village is realized by trains B. For loading of these containers the train C has to arrive to the freight village. After loading the train B leaves the freight village.

3. Conclusions

On the point of view of the average daily trucks number the highest values are reached for Bohumín-Vrbice, but we can say that the differences between particular locations are not significant. For version II the average daily number of trucks is approximately higher by 100 than the average daily number of trucks for version I and III.
The highest average annual performance in [TEU] was reached for locality Mošnov and for version II, but the differences between locations are not remarkable again.
Versions I and III (configurations of this versions are very similar) represent state of freight village after its building. After increase of demand on freight village services we can expect increase of its requested performance. This state is simulated by version II.

4. References

[1.] MÍKOVÁ, J., DORDA, M., FAMFULÍK, J.: **Veřejné logistické centrum v Moravskoslezském kraji** (Freight Village in Moravian-Silesian Country). *Perner's Contacts* [online]. 4/2008, p. 74-81. ISSN 1801-674X. Available from <http://pernerscontacts.upce.cz/11_2008/mikova.pdf>.

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This paper was created within Operational Programme Infrastructure on the basis of project outcomes named „Situation and Development Opportunity of Logistic Infrastructure in Moravian-Silesian Country with Emphasis on Freight Village Building".