



FAIR MERCHANDISE SUPPLY SIMULATION MODEL

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Abstract: *This work resulted from the research conducted at the Novi Sad Fair. The study was conducted for the following fair events: International furniture, design and interior equipment exhibition “Ambijenta”, International Book Fair and Exhibition of Art “Art expo”.*

Data collection on the distribution vehicles arrival times was conducted at the entrance to the exhibition area, whereas the information on the fair merchandise unloading process was gathered at three points designated for unloading the distribution vehicles. This paper presents the analysis of the distribution vehicle arrival patterns and servicing flows within the fair merchandise supply. A model of fair merchandise supply was developed and tested through simulation.

The aim of this paper is based on the collected data to analyze the working process of distribution vehicles and fair merchandise supply for the aforementioned events. Furthermore, we aim to establish whether the system is in optimal state and, if evidence is found to the contrary, propose measures for its improvement.

The results of the above analysis were used to develop a fair merchandise supply simulation model for the case of Novi Sad Fair. The simulation utilized GPSS (General Purpose Simulation System).

The fair merchandise supply process was modeled by considering the distribution vehicle unloading procedures at three locations, assuming exponential distribution of arrivals and unloading services. The duration of the simulation was 720 minutes, corresponding to the time period between 7 and 19 o'clock.

In order to produce more reliable simulation results, the average value obtained from five simulations using different random numbers was used. The parameters obtained in the simulation suggest that the Novi Sad Fair supply quality is satisfactory. However, several measures that would lead to better performance and increased supply efficiency are proposed.

The developed fair merchandise supply simulation model is of great significance, as it can be generalized to simulate the arrivals and unloading of distribution vehicles for a wide range of events and services.

Key words: *GPSS, Novi Sad Fair, Supply.*

INTRODUCTION

Research for this paper was carried out at the Novi Sad Fair. Novi Sad Fair is the leading trade fair company in Serbia. Besides organizing fairs and exhibitions, it is also involved in organizing congresses, conferences, marketing services, warehousing and hospitality. In the area of the fairgrounds there are 37 halls and total exhibition space is 300,000 m². 30 events in 10 terms are held annually with over 1.2 million visitors [1].

The survey was conducted for the following fair events:

- International Exhibition of Furniture, Design and Interior Decoration “Ambijenta”;
- International Book Fair;
- Exhibition of Art “Art Expo”.

International Exhibition of Furniture, Design and Interior Decoration “Ambijenta” was held in Halls 1, 3 and 4, while the International Book Fair and Exhibition of Art “Art Expo” were intended for Master Center.

The subject of this paper is to analyze incoming streams and ground handling streams of distribution vehicles for these fair events that are held in the same period in Halls 1, 3, 4, and in the Master Center. Data collection was conducted in three places, because there are three places for the unloading of vehicles (Fig. 1). A special unloading place for the Hall 4 does not exist, so there is a common unloading place for Hall 3 and Hall 4.

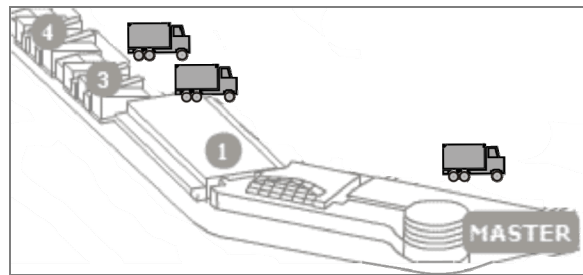


Fig. 1 Unloading space for distribution vehicles

In the observed system input stream is the time between arrivals of vehicles for the distribution of fair goods and flow of ground handling is the time for the unloading of vehicles. The distribution of arrivals and ground handling of vehicles was tested for 100 vehicles. To determine the legality of the input flows statistical tests of a representative sample are carried out. Evaluation method for distribution of the time for ground handling is the same as the evaluation method for the input stream. The intensity of arrivals of vehicles $\lambda=0.1$ vehicles/min was obtained by statistical analysis, while the intensity of ground handling of vehicles was $\mu=0038$ vehicle/min.

The obtained results were used to form a distribution model to at the Novi Sad Fair and to simulate the current situation. Simulation language GPSS (General Purpose Simulation System) was used for simulation.

The aim of this paper is to do an analysis of work for the distribution vehicles for some fair events based on the collected data and determine whether the situation is optimal, or if not, to propose measures for its improvement.

GENERAL FACTS ON MODELLING AND SIMULATION

Methods of mathematical modeling and simulation are more and more used in solving the problems of stochastic and deterministic character. These methods represent upgrading of analytical methods of mass handling [2].

The model represents a “copy”, ie. simplified and idealized picture of the real system and can be formed by one or by a combination of the following ways:

- physical object (model), reduced or enlarged;
- abstract, when presented in mathematical equations;
- graphically;
- computationally.

Modeling is the process of formation of models by observing the real systems [3]. The goal of modeling is to create a model which will be more valid in presenting the real system and as simple as possible. Models related to the simulation are called simulation models.

The simulation represents an experimentation on a softwer realized model. In other words, modeling is the process of establishing a connection between the real system and the model, while the simulation is the process that refers to the connection between the computer and the model (Fig. 2).

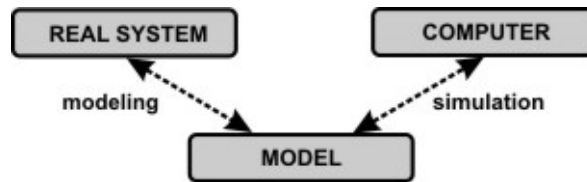


Fig. 2 Relations between modeling and simulation

More recently, simulation of continuous systems is done on digital computers, thanks to the special languages for simulation. They consist of a simulation language, processor and the set of blocks (functions). Such languages are CSMP, DINAMO, Matlab (Toolbox), ACSL, CSSL, Tutsi, SIMULINK and others.

GPSS is a simulation system in which in a simple way, using the commands of a built-in language, the structure of the model is specified and simulation is performed [4]. When the simulation is finished, statistical data on the behavior of the model during the simulation are available.

GPSS language is based on processes. The program is composed as a set of process descriptions in the shape of parts of the program which follow the sequence of activities and operations that are, upon their performance, performed on attributes of the object model.

The basic elements of the model described in this simulation language are as follows: [5]

- transactions;
- static entities;
- declaration commands;
- block commands;
- control commands;
- compiler directives;
- standard numerical attributes.

FORMATION OF SIMULATION MODEL

For modeling of the supply process at the Novi Sad Fair it is considered the procedure of unloading of distribution vehicles at three ground handling locations. The duration of the simulation is 720 minutes, that is, working time from 7am to 7pm.

The random numbers are of great importance for conducting the simulation process. By repeating the simulations for different random numbers we get the different results. However, the random numbers which are generated in GPSS are not quite random and they are called pseudorandom numbers, because they are generated by the appropriate algorithm. This means that after a while the numbers can be repeated [6]. GPSS model used in this paper supports eight different random number generators.

In order to get more competent simulation results, the average value of the maximum number of vehicles in the row and the mean number of vehicles in the row for five different simulations is calculated. The average maximum number of distribution vehicles in the row is 22 vehicles, and the average value of the mean number of vehicles in the row is 10 vehicles (Fig. 3).

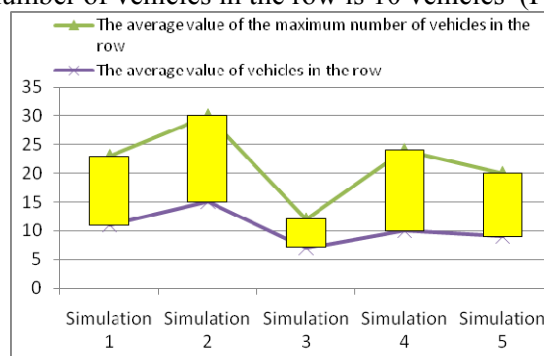


Fig. 3 Simulation results

The average utilization at the ground handling locations is 0.76, 0.64 and 0.47, respectively (Table 1). The average time for unloading vehicles at the ground handling locations is 28, 23 and 22 minutes (Table 2), so the arithmetic mean of the three values is 24 minutes.

Table 1. The average utilization of the ground handling channel

	Ground handling 1	Ground handling 2	Ground handling 3
Simulation 1	0.79	0.59	0.41
Simulation 2	0.76	0.68	0.40
Simulation 3	0.69	0.57	0.49
Simulation 4	0.79	0.72	0.63
Simulation 5	0.75	0.64	0.40
Average value	0.76	0.64	0.47

Table 2. The average time for ground handling of vehicles

	Ground handling 1	Ground handling 2	Ground handling 3
Simulation 1	35.13	22.32	14.53
Simulation 2	29.47	23.10	18.60
Simulation 3	20.61	21.06	23.33
Simulation 4	23.04	22.35	37.42
Simulation 5	29.72	25.17	15.89
Average value	≈28	≈23	≈22

ANALYSIS OF WORK AND PROPOSED MEASURES TO IMPROVE BUSINESS

Favourable work organization of the queuing system assumes on one hand a sufficient commitment of the system, and on the other a satisfactory level (quality) of the ground handling [7]. The quality of the ground handling is largely related to the time spent in the queue. In this sense, better handling is considered to be one that provides the shortest possible time users stay in line.

Ground handling system we observe is fully determined by three quantities: the number of ground handling locations (n), the intensity of arrivals (λ) and the mean time of ground handling (t) [8]. These are the parameters used in the system operation analysis and whose variations change the quality of ground handling. Each of the three sizes can be managed in an appropriate way [9].

According to results, we conclude that the quality of ground handling at the Novi Sad Fair for the listed fair events is satisfactory but measures that would lead to its improvement can be proposed. It should be noted that the largest footprint of any exhibition event is one day before the start and then we have the emergence of bottlenecks and the longest queues.

The number of ground handling channels can be increased or decreased as required, if the appropriate resources are available. There are no physical conditions to increase the number of ground handling locations in these halls at the Novi Sad Fair. If this measure is applied as a final option, it would be a huge financial investment, because of that, solutions for improving the quality of work should be sought in other ways.

In the scientific and technical literature there are different opinions when we talk about utilization of the ground handling channel [10]. There are two approaches to this problem: “Eastern” and “Western”. According to the “Eastern” approach it is considered that ground handling channel occupancy must not exceed 0.7 - 0.75. The “Western” approach gives greater emphasis to the service quality and according to it, ground handling channel occupancy should not exceed 0.6 and even 0.5.

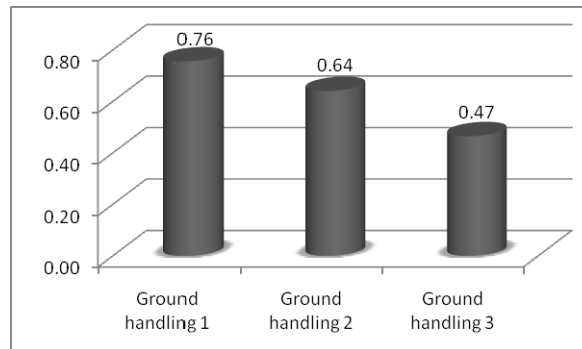


Fig. 4 The average ground handling channel utilization

If we consider the commitment of elements in the model for existing technologies at the Novi Sad Fair, we can conclude that the ground handling location 1 functions in overloaded operational conditions. It can be said that the ground handling location 2 has the optimal capacity utilization, while the ground handling location 3 has the certain provisions in its utilization. One of solutions for improving the service qualities would be to increase the utilization of capacity of the ground handling location 3. The research in the field led us to the conclusion that the greatest delays in the distribution are caused by frequent arrivals of vehicles in prime time from 10am to 2pm. In order to avoid the longest queues in this period, the arrival of distribution vehicles should be better organized by creating a new informational system. It would be achieved by better planning of distribution vehicles arrivals, where each vehicle would be assigned a certain delivery time. Vehicles would come more evenly throughout the day and the long queues would be avoided. In this way the access of vehicles into the system would be managed by directing some users to arrive at the time of less utilization of certain ground handling locations.

By mean time of ground handling, we can manage the better organization of ground handling, introduce a higher level of automation or delay activities that are not necessary. Technologies that are now represented in the handling of goods at the fair are relatively old and inefficient. There is the possibility of introducing new and more efficient technologies, especially in the way of unloading the shipment to its reserved booth.

When introducing new technologies of unloading and managing the goods in the halls, the environmental criteria should be taken into account. Transport of goods in the fair halls, as part of a fair manifestation, is a significant source of noise and pollution, considering exhaust gases. Therefore, a significant advantage is given to the electric vehicles which would replace the current diesel-powered vehicles. In addition, electric vehicles do not emit harmful gases and generate a slight noise. The disadvantage is that the batteries for electric vehicles, which are used as a source of energy are expensive, massive and heavy, so their use is restricted.

CONCLUSION

The Novi Sad Fair, as the leading trade fair company in Serbia and the region should maintain a high level of service qualities and increase the volume of business. Such a concept is impossible without the use of modern and efficient technologies. That is why in this paper the analysis of the distribution of arrivals of vehicles is carried out for the following fair events: International Exhibition of Furniture, Design and Interior Decoration “Ambijenta”, International Book Fair and Exhibition of Art “Art Expo”. Simulation model developed in the paper enables simulation of arrivals of the distribution vehicles for any exhibition event.

One of the directions for the further development of the Novi Sad Fair is the design of new information technologies, especially for the more balanced arrivals of distribution vehicles. This would avoid over loaded terms from 10am to 2pm which cause long lines waiting to unload. This would improve the management of vehicle access into the system and increase the use of ground handling capacity of the channel. The following measure which would significantly increase the operational efficiency and reduce the time for ground handling is the introduction of new technologies

for the unloading of the goods and its delivery to the appropriate stand in the hall. It is very important to increase the level of automation of all activities at the Novi Sad Fair. This would lead to the significant savings in time needed for ground handling and waiting, as well as reducing the number of employees.

The Novi Sad Fair, as well organized and modern company, by introduction new technologies must take into account the ecology as well. Therefore the introduction of “green” technologies is recommended, with special emphasis on the use of vehicles with electric drive.

Further directions of research can be directed to a web simulation. In recent years, numerous papers in this field appeared. Research area for web simulations is quite active for researchers because it is still at the beginning of development, and significant efforts are made to include new simulations, in addition to conventional ones. Although web simulations look promising, the number of applied applications and efficient tools is still very low [11]. Therefore, further researches should be identified in this area, so as to develop a web simulation and compare its results with the results of classical simulations.

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ИМИТАЦИОНЕН МОДЕЛ ЗА ДОСТАВКА НА СТОКИ ЗА ПАНАИР

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СЪРБИЯ

Ключови думи: GPSS, панаир в Нови сад, доставка.

Резюме: *The results of the above analysis were used to develop a fair merchandise supply simulation model for the case of Novi Sad Fair. The simulation utilized GPSS (General Purpose Simulation System).*

Този доклад е резултат от изследване, проведено на панаира в Нови Сад. Изследването е проведено за следните панаирни събития: Международната изложба на мебели, дизайн и интериорно оборудване "Амбийента", Международен панаир на книгата и изложба на изкуствата "Арт експо".

Проведено бе събиране на данни за разпределението на времето за пристигане на превозните средства на входа на изложбената площ, докато информацията за процеса на разтоварване на стоки събрана от три точки, определени за разтоварване на дистрибуторските превозни средства. Настоящият доклад представя анализ на структурата на дистрибуторските превозни средства при пристигане и обслужващите потоци в рамките на доставка на стоки на панаира. Разработен е модел на доставка на стоки за панаира и е тестван чрез симулация.

Целта на този доклад е на основава на събраните данни да се анализира процесът на работа на дистрибуторските превозни средства и доставката на стоки на панаира. Освен това стремежът е да се установи дали системата е в оптимално състояние и ако има доказателства за обратното, да се предложат мерки за неговото подобряване.

Резултатите от горния анализ са използвани за разработване на имитационен модел за доставка на стоки за панаира в Нови Сад. Симулацията използва системата GPSS (General Purpose Simulation System).