Trade fair exhibition organization simulation model

Vladimir Ilin, Dragan Simic, Nenad Saulic

Abstract— Fair Trade (FT) plays an important role in the regional promotion and development. Exhibitors mostly observe FTs as an opportunity to promote their products and activities. Number of exhibitors, the quality of their products and their origin affect the number of FT visitors. Logistics support is needed in order to adequately organize such a manifestation. Also, a detailed preparation plan and schedule are essential for high organizational level and smooth supply execution. The objective of this paper is to describe, analyze and simulate servicing of Novi Sad tourism FT exhibition. The queuing theory was basis for data analysis and determination of characteristics of operating channels. The primary focus of the queuing theory was to define main principles of how the system works and to enable appropriate basis for computer analysis. The FT exhibition supply process was modeled taking into account the distribution of vehicle unloading procedures at two locations, assuming Poisson distribution for arrival rates (λ) and Exponential distribution for service rates (μ). Software Matlab with its toolbox Simulink were used for the generation of the computer simulation model. The final step was to incorporate determined inputs (λ and μ) into simulation model and to analyze results. The outputs were multiple parameters of the FT system. Additional possibility was to predict and define requirements for more demanding servicing capacity. Obtained parameters from the simulation imply that the Novi Sad FT supply quality is satisfactory, but can be enhanced. Therefore, several measures that would lead to an improved performance and increased supply efficiency are proposed. Furthermore, the paper establishes links between logistics, exhibition organization processes and software support. The most important contributions of this paper are: (i) computer simulation of the real system with multiple opportunities for detailed analyses, predictions and improvement of decision-making processes (ii) correlation between closed-loop supply chain and FT exhibition organization and (iii) comprehensive analysis of Novi Sad FT exhibition and consequently, insight into regional economic development and progress.

Index Terms— FT exhibition, closed-loop supply chain, Simulink, queuing theory, Matlab simulation

1 Introduction

Organization have for a long time tried to optimize and improve the physical material flow within the various and complex supply chains, trying to gain competitive advantage [1]. Today, material and information flows are suffused and present key factors in all complex organizational networks. Fair Trade (FT) exhibition is an organizational structure in which the optimization of material and information flows have central role. Traditionally, FTs are defined as events that bring together, in a single location a group of suppliers who set up physical exhibits of their products and services from a given industry or discipline [2]. According to the World Fair Trade Organization (WFTO), FT is a trading partnership, based on dialog, transparency and respect, which seeks greater equity in international trade. It contributes to sustainable development by offering better trading conditions to, and securing the rights of, marginalized producers and workers [3].

The paper has three main objectives:

1. To point out significance of FT exhibition for the city of Novi Sad and for the region,
2. To determine correlation between FT exhibition organization process and closed-loop supply chain, and
3. To propose computer simulation model of the real system with multiple opportunities for detailed analyses.

- *Vladimir Ilin, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia. E-mail: v.ilin@uns.ac.rs*
- *Dragan Simic, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia. E-mail: dsimic@eunet.rs*
- *Nenad Saulic, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia. E-mail: n.saulic@uns.ac.rs*

However, the main purpose is to evaluate FT performance through main parameters (Lt, Lq, Wt, Wq and U) in the simulation model. Detailed description of parameters is given in Section 4. Queuing theory thoroughly describes all parameters [4] and helps the generation of the simulation model. Simulation was performed in software MATLAB and its toolbox Simulink. In order to obtain outputs from the simulation model, precise inputs are required. Data are collected and statistically analyzed on the basis of a quantitative research during FT exhibition. Arrival rates (λ) and service rates (μ) are than calculated and input preparation was completed. The final step was to design simulation model and test it. This was the most complex step and the main contribution of this paper.

The paper is organized as follows. In the second Section a FT framework and its significance is considered and discussed. More importantly, FT layout is presented. In the third Section, correlation of FT and management logistics concept is determined. The fourth Section shows simulation model, detailed blocks description and main results. The last Section provides a sketch of a transition situation in which Serbia is, future measures for FT improvement and future research.

2 Fare Trade Framework and Significance

The FT which was analyzed in this paper is in the second largest city in Serbia – Novi Sad. Novi Sad FT was founded in 1929. It spreads on the area of 226.000 m^2 and the indoor exhibition area covers 60.000 m^2. There are 37 halls, among which the most up-to-date is the Master Hall, which offers 5.970 m^2 of exhibition area. Novi Sad FT Congress Centre covers 2.230 m^2. Six small and one large hall facilitate organization of two

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simultaneous events for 1.000 and 350 people [5]. Tab. 1 shows the framework of this research.

TABLE 1
BASIC INFORMATION ABOUT THE RESEARCH

Observed FT manifestation	Tourism Fair
Type of research	Quantitative research
The aim of research	To identify main characteristics of arrival rates and service rates (λ and μ) during supply of FT's activities in the city of Novi Sad
Target groups	Trucks, vans, cars
Obtained results	112 vehicles recorded, 96 used in simulation model (90,57%)
Research period	October 2012.

Very important aspect of comprehensive analysis is a current situation in Serbia – a transition. The most of European countries have passed through this phase and all of them are familiar with possible difficulties and obstacles which can occur for many organizations due to lack of well-defined legislation and professional knowledge. These aspects are very important for understanding external factors which may intensely affects organizational processes. Three strongest factors are:

1. Financial – highly variable number of exhibitors and visitors,
2. Organizational - many companies retained the old habitual way of doing business without a tendency to incorporate innovations, and
3. Professional – noticeable lack of skilled experts.

FT exhibition has a very important role for the city and for the region, respectively. Considering that the city of Novi Sad is the main pillar in the region, analysis of such a manifestation gains a greater significance but also provides an overview of the organizational potential and a mirror of the regional economy. Using modeling and simulation in organizing, assembling and scheduling is a necessity required by the fact that these systems have to satisfy stricter requirements imposed by the market, including increase of quality and precise delivery time [6]. Good coordination between these steps is very important because of the short period of the manifestation preparation time (1 day before the exhibition). The simulation model is thus very significant predictor of any potential bottlenecks and associated problems. Also, prediction of main parameters may show direction in which managers should focus most of their efforts and attention.

Queuing theory plays significant role in this paper. Arrival rates (λ) and service rates (μ) are considered as main parameters in the model formulation. Application of queuing theory in FT manifestations hasn't been conducted in the past, which emphasizes significance of this analysis. However, FT manifestations are very convenient for optimization analysis of exhibition space and layout. P. Schneuwly et al. [7] proposed layout modeling and construction procedure for the arrangement of exhibition spaces in a FT. This paper was a springboard for further analyses of a FT and optimization solutions. A. E. F. Muritiba et al. [8] analyzed optimal design of FT layout. Several basic mathematical programming models were elaborated and their enhancement is proposed. Although, layout optimization analysis hasn't been performed in this paper, exhibitors schedule is shown in Fig. 1. Novi Sad FT managers created this layout with the help of professional knowledge and experience. At the same time, they take into consideration both, exhibitors' and visitors' requirements and needs.

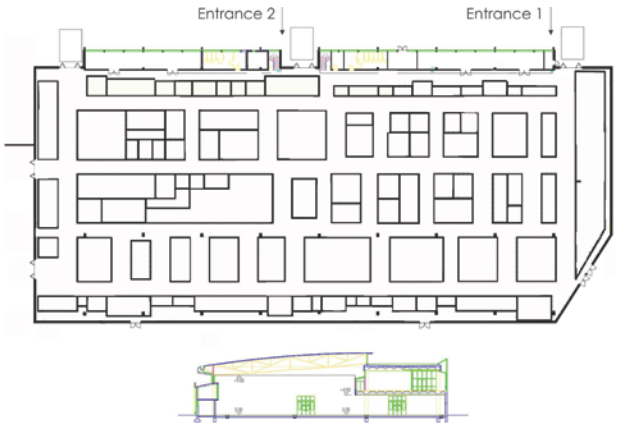

Fig. 2. Novi Sad FT exhibition Hall

3 CORRELATION BETWEEN FARE TRADE AND CLOSED-LOOP SUPPLY CHAIN

Nowadays logistics plays the strategic role in most organizational processes. In the case of Novi Sad FT exhibition correlation between closed-loop supply chain and FT organization is identified and shown in Fig. 2. Incorporation of logistics in organizational processes has several goals [9]:

- To optimize all processes,
- To generate added value,
- To identify and eliminate weak spots,
- To coordinate between people and their assignments and problems along the way,
- To create new configurations of products, services and possibilities,
- To emphasize exhibitor's competitive position on the market,
- To achieve success in lead of core logistics activities, etc.

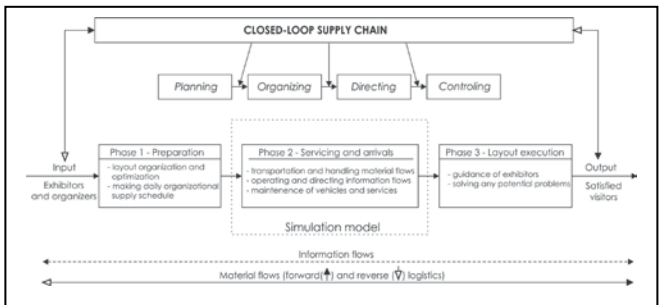

Fig. 2. Illustration of closed-loop supply chain in an FT organization

Logistics is concerned with getting products and services where they are needed and when they are desired [10]. In accordance with this, an FT manifestation is considered as

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closed-loop supply chain (encompassing forward and reverse logistics approach). Closed-loop supply chain system has to provide answers for a wide range of issues including planning, organizing, directing and controlling the flow of materials, people, energy and information.

Forward logistics approach has three phases: preparation, servicing and arrivals and layout execution. Each phase requires thoroughly developed strategy with precise tasks and the execution order. This paper is mostly concerned with the second phase and forming of the simulation model, but opportunities for different analyses approaches are multiple. In order to achieve high organizational level and smooth supply execution partnership relation between FT organizers and exhibitors with all necessary conditions needs to be defined. The necessary condition for partnership includes: shared understanding, mutual commitment, distinct contribution, shared objectives and trust [11]. Proper functioning of all of these steps is required to minimize any potential problems during supply process.

Reverse logistics approach implies all processes and activities correlated with reverse material flows. In general, exhibition amounts are not equal in forward and reverse directions, because of the possibility of visitors buying most of the products. Reverse logistics support facilitates all processes during reverse flows making them more transparent and visible.

Fig. 3 shows geographical allocation of exhibitor's origin and Novi Sad FT destination. This illustration is important in order to point out the need for logistics support during organizational and execution phases.

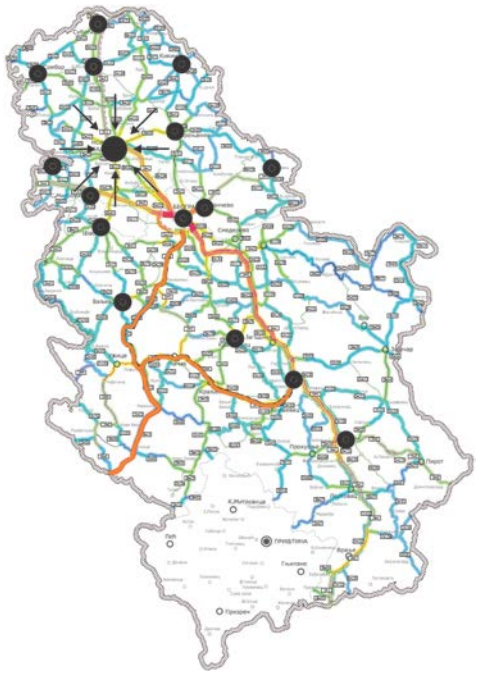

Fig. 3. Geographical allocation of exhibitors and Novi Sad FT exhibition

4 Simulation Model and Results

Obtained data from the quantitative research are merged in one dataset in Excel. The first step was to calculate arrival rates (λ) and service rates (μ) in order to facilitate input preparation for the simulation model. FT exhibition supply process was modeled by considering distribution of vehicle unloading procedures at two locations, assuming Poisson distribution of arrival rates and Exponential distribution of service rates.

Simulation analysis of FT exhibition is significant for multiple reasons:

- Comprehensive analysis of obtained results,
- Full insight into FT organizational strengths and weaknesses,
- Transparency of all processes,
- Simplified modification and process enhancement,
- Burden prediction,
- Decision – support clarification,
- Future measures for improvement, etc.

Software MATLAB, queuing theory, and discrete-state model, play a vital part in the generating simulation model and outputs analysis. Specifically, software MATLAB with its toolbox Simulink was used to create simulation model (Fig. 4). MATLAB provides a relatively easy-to-use, versatile, and powerful simulation environment for investigating the basic, as well as clinical, aspects of dynamics systems [12]. Simulink is an environment for multi-domain simulation and model-based design for dynamic and embedded systems. It provides an interactive graphical environment and a customizable set of block libraries that offer the possibility to design, simulate, implement, and test a variety of time-varying systems, including communications, controls, signal processing, video processing, and image processing [13]. Model is created using Simulink's SimEvents section with different blocks. The final output was simulation model by which data were tested.

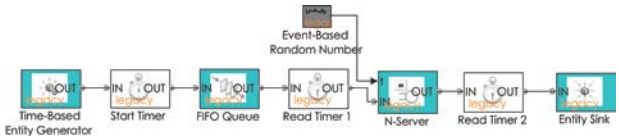

Fig. 4. Basic blocks in the simulation model

The graphical drag and-drop interface in Simulink was basis for building a discrete-event model. The key feature includes [14]:

- Libraries of predefined blocks, such as queues (FIFO queue), servers (N-server), timing (Start timer and Read timer), generators (Time-based entity generators) and sinks (Entity sink and Signal scope) for modeling system architecture. Blocks are explained in Tab. 2;
- Built-in statistics such as number of entities in queue and in block, average elapsed times, number of entities timed-out and utilization;
- M-function for calculating main results.

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TABLE 2
DESCRIPTION OF BLOCKS FROM THE SIMULATION MODEL

Blocks	*Description*
"Time-Based Entity Generator"	Designed to generate entities using integration times that satisfy specified criteria. The integration time is the time interval between two successive generation events. In this paper Poisson distribution is determined/assumed and according to that the adequate parameter λ=4,68 h^{-1} is entered.
"Start Timer"	Associates named timer to each arriving entity independently and start timing. It has two ports: the first one is for arriving entities and the second one is for departing entities.
"FIFO Queue"	Stores entities in sequence first-in, first-out for undetermined length of time.
"Read Timer"	Reports statistical data about named timer associated with arriving entities.
"N-Server"	Stores up to N entities, serving each one independently for a period of time and then attempting to output the entity through the OUT port.
"Event-Based Random Number"	Generates random numbers from specified distribution, parameter and initial seed. Parameter μ=4,22 h^{-1} is entered.
"Entity Sink"	Accepts all block entities and provides a way to terminate an entity path.

Arrival rates and service rates are measured for 12 hours period, during which the FT exhibition supply process was operating. Based on queuing theory, calculated parameters (λ and μ), and created simulation model in Simulink, simulation results are presented for 24 hours period in Tab. 3. The duration of the system simulation was 12 hours, corresponding to the time period between 7 a.m. and 7 p.m., which presents the executive period of supply processes. Prediction results are shown in the case of potential extended functionality of the system for additional 12 hours. While simulating, the main principle was to constantly increase the simulation time in the simulation model for exactly 1 hour in order to observe how parameters (mostly Lt, Wt and U) are changing during the working time. Entries and exits of vehicles to and from the system, as well as multiple operations with the exhibition material, are possible only during executive period. Before and after that period ramps are closed and entrances in FT halls are possible only with special licenses authorized by organizers. These two periods without vehicles entrances are identified from logistics perspectives as preparation time and organization time. The first one implies the appropriate logistical organizational scheme (including material and information flows and people), while the second one involves the applicable logistical layout schedule for exhibiters and their exhibits.

Nomenclature of indices (Tab. 3),
Lq – mean number of vehicles in the queue,
Ls – mean number of vehicles on servicing,
Lt – mean number of vehicles in the system (Lq+Ls),
Wq – mean time vehicles spent in the queue,
Ws – mean time vehicles spent on servicing,
Wt – mean time vehicles spent in the system (Wq+Ws),
U – utilization of the system.

TABLE 3
SIMULATION AND PREDICTION RESULTS FROM THE SIMULATION MODEL

Simulation results							
	Lq	*Ls*	*Lt*	*Wq*	*Ws*	*Wt*	*U*
1h	0	0,18	0,18	0	0,23	0,23	0
2h	0,10	0,75	0,85	0,77	3,77	4,54	0,14
3h	0,09	0,76	0,85	0,99	6,34	7,33	0,22
4h	0,07	0,85	0,92	1,02	7,67	8,69	0,26
5h	0,05	0,74	0,79	0,97	8,19	9,16	0,29
6h	0,05	0,82	0,88	0,92	8,47	9,39	0,31
7h	0,05	0,85	0,89	0,88	8,76	9,64	0,32
8h	0,12	0,95	1,07	0,85	9,08	9,93	0,34
9h	0,26	1,05	1,31	1,02	9,46	10,48	0,35
10h	0,23	1,07	1,30	1,23	9,9	11,13	0,37
11h	0,21	1,02	1,23	1,39	10,25	11,64	0,39
12h	0,19	1,04	1,23	1,49	10,53	12,02	0,40
Prediction results							
	Lq	*Ls*	*Lt*	*Wq*	*Ws*	*Wt*	*U*
13h	0.18	1.02	1.19	1.56	10,74	12.30	0.41
14h	0.17	1.01	1.18	1.61	10,95	12.56	0.41
15h	0.21	1.04	1.26	1.68	11,12	12.80	0.42
16h	0.21	1.07	1.28	1.75	11,31	13.06	0.43
17h	0.21	1.09	1.30	1.80	11,46	13.26	0.43
18h	0.20	1.06	1.25	1.85	11,6	13.45	0.44
19h	0.19	1.03	1.22	1.88	11,74	13.62	0.44
20h	0.29	1.08	1.36	1.92	11,83	13.75	0.45
21h	0.50	1.12	1.62	2.03	11,93	13.96	0.45
22h	0.51	1.16	1.67	2.23	12,05	14.28	0.46
23h	0.51	1.18	1.70	2.43	12,17	14.60	0.46
24h	0.49	1.14	1.64	2.60	12,28	14.88	0.47

Simulation results for 12 hours period show that the system was at the steady state during the whole period ($C * \mu > \lambda$). Those results were expected due to determined inputs (λ and μ) and their determined similar values. The total number of vehicles in the system ranges from 0,18 to 1,23 which implies that bottlenecks have not occurred. Similarly, the total time vehicles spent in the system ranges from 0,23 min. to 12 min. which indicates that vehicles were unloaded very fast, and without unnecessary detention. Maximal efficiency for the 12 hours period burdened has a value of 40%. Additional efficiency is possible depending on how long the system works.

Prediction results for 24 hours operating scenario do not show significant changes in the parameter values which suggests that the real-system can function with the same capacity for 24 hours without bottlenecks and system burdens. This may be important because of unpredicted organizational re-

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quirements which may always occur and potential situations in which FT has to operate for longer period than usually.

5 Final remarks and future research

The most important contributions of this paper are: (i) computer simulation of the real system with multiple opportunities for detailed analyses, predictions and improvement of decision-making processes (ii) correlation between closed-loop supply chain and FT exhibition organization and (iii) comprehensive analysis of Novi Sad FT exhibition and consequently, insight into regional economic development and progress. Proposed simulation model and calculated and predicted parameters present a good basis for further research on this topic.

Future measures which will improve the process organization and execution are:

- Automation in halls,
- Logistics information system,
- Additional parking spaces.

Future research can be extended in logistics comprehensive analysis direction. For example, transportation, as a separate phase, can be observed and discussed. Additional data are than required for further analysis: types of exhibit materials (diffused, in peace, liquid etc.), types of flows (incoming, outgoing, internal), types of transport and different transport means (e.g. by roads, water, rail or air. Road transport is the most common and there are many vehicle categories which can be analyzed.), etc.

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