SIMULATION AS A TOOL FOR EXTRACTING KEY PERFORMANCE PARAMETERS IN POSTAL LOGISTIC CENTERS

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Abstract: *Today, postal operators are becoming more and more market-oriented and customer-driven. As a consequence of that, many of the traditional postal centers expanded their service in area of logistics and transform itself in postal logistics centers (PLC-s). Prior orienting to the providing logistic services management of PLC needs to determine current key performance parameters while performing basic postal activities, driven from defined business objectives of postal service. In order to determine PLC capabilities for additional logistic services, first step is to know how much resources can be redirected to the those new logistic services. This paper deals exactly with this kind of problem, and we propose the simulation of postal processes in PLC, using discrete event simulation (DES), as a methodology approach for extracting and representing the influence of different worker layouts on overall processing time in PLC. Accordingly, simulation model of current operation conditions in PLC was created (AS-IS model).*

Keywords*: postal logistics centers, discrete event simulations, mails, postal processes, logistics performances.*

1. INTRUDUCTION

Postal service plays a significant role in the development of a leading commercial and financial regions, providing communications between individuals, business and government. In recent years, postal operators are facing with the challenges of rapid technological development, market liberalization, segmentation and increasing competition. In such conditions, the industry has evolved to include traditional post (like package and mail delivery), courier services, freight services and e-services (Chan et al., 2006) in logistics fright flows, and leading European postal operators (such as: Deutsche Post DHL, La Poste and Royal Mail) have expanded their operations in the logistics sector. This development of the postal sector is conditioned by the rapid development of e-commerce, which, among other things, includes a strong logistics.

PLC are important link in the delivery of shipments between the sender and the recipient. Their main function is collecting and distribution of large quantities of shipments in the postal network. Postal processes that are carried out in these centers, arising from defined business objectives of postal service and generally include: sorting of postal shipments, organizing the transport and provision of postal and logistics services. Heterogeneity of postal shipments in the PLC causes various postal activities in order to process different mails. Depending on the shipments type, depends which resources will execute the processing and in what manner. Different mails have different lead times, and acquire different resources for processing, which

implies different costs of processing. Bearing in mind the global determinants of postal operators and the structure and characteristics of the business processes in postal service, it is clear that the logistics as an instrument of differentiation and rationalization, should be integral component of the postal operators business strategy (Kujačić et al., 2013). In order to determine the level of efficiency of executed processes in PLC-s, it is necessary to establish procedure to extract the measures of logistic performances of basic postal operations in the PLC. For that purpose we used DES of basic postal processes in PLC, and we focused on determining overall processing time of mails, taking into account engaged number of workers.

2. STRUCTURE OF THE POSTAL NETWORK AND BUSINESS PROCESSES IN THE POSTAL SERVICE

The key characteristics of postal services is reflected in the massive user demand for transfer of postal items, which is realized through postal processes that generate physical moving of mails with aim of their transfer to the recipient. From an organizational point of view, for the implementation of postal services that demands the market (national operators are conditioned to also to provide a universal service) it is necessary to establish a uniform postal network (on national and international level), and use of unique technologies and standardization of equipment. The structure of the postal network and its equipment is conditioned by the economic capabilities of operators, traffic volume, and in the case of a national operator, government investment policies.

From the logistical point of view, a PLC performs the function of intra logistics (Lisec and Rihter, 2007), and as a units of postal network, PLC are located in the traffic hubs in order to achieve the concentration and diffusion of shipments on the geographical area that they cover, and consequently, they have a key role in the concentration, processing, delivery and transshipment of received mails. Recently, Serbian Posts constructed three new regional PLC hubs (Belgrade, Novi Sad and Nish), and performed automatization of mails processing. In the PLCs Novi Sad and Nish automatization is caried out only for the letters with standard sizes (dimensions from 90x140 mm to 120x235 mm), while in PLC Belgrade automatization also included the automatization of parcel deliveries. For more details about organization of postal-logistics processes, especially about organization of postal service in Serbia, refer to (Kujačić et al., 2013).

3. CASE STUDY OF PLC

The case study was carried out on the example of PLC Novi Sad (Republic of Serbia). In a simplified analysis PLC Novi Sad can be considered as post hub with basic function of receiving, sorting, delivery and transshipment of incoming mails. In the observed PLC different mail classes are processed (priority mail express, first class mails, standard mails and international mails). Priority mail express represent service which allows fastest transfer all kind of mails (letters, parcels, advertisements, bills, etc.). This service also provides tracking of shipments during transfer, and service is available only in domestic traffic (i.e. within the boundaries of the Republic of Serbia). First class mails includes valuable parcels and valuable letters. By business practice of Post of Serbia, for valuable parcels medium and large packages are considered. Valuable letters are special kind of postal shipments, which are processed in separate section of PLC, since they are confidential contracts between companies, they can be international shipments and government shipments. By standard mails Post of Serbia consider: advertisements, circulars, newsletters, small parcels, merchandise, bills, etc. Standard postal items are classified on the basis of their dimensions, and in practice of Serbian Posts classification is performed on the ordinary and nonordinary mails. Ordinary mails include letters with standard dimensions which are consisted from recommended letters and priority mails. Recommended letters are similar shipments as post mail express. They also allow tracking of letters and but they are slower than the post mail express shipments. Priority mails are mails

which have priority in delivering to the final consumer, and usually there are consisted from bills for electric energy, TV, and other kind of government taxes. Accordingly, during processing in the PLC different shipments (i.e. mail classes) have different sequence of activities through PLC, and by average 7 000 000 mails are processed in PLC Novi Sad, for one month. Typical flow of mails through PLC Novi Sad is shown in Figure 1.

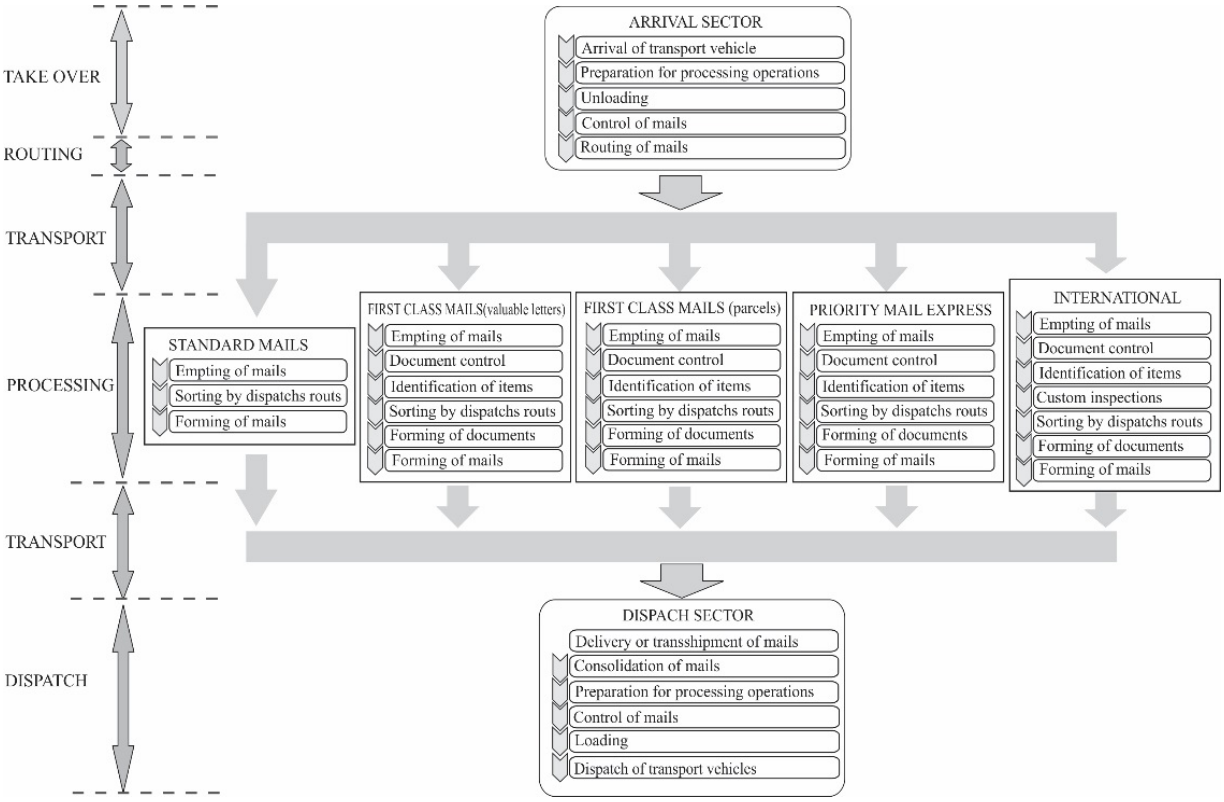

Figure 1. Flow of mails through PLC (adapted from (Kujačić et al., 2013))

3.1 As-Is

Simulation of current operation conditions in the PLC (AS-IS model), is carried out using the several databases and experience gained from vocational training in the PLC. Following the logic of Figure 2, and using data about time duration for each activity from document "Postal statistics" (Đakovački, 2006) and also data related to actual layout of activities (determined from vocational training in PLC), PLC Novi Sad is simulated. As a result AS-IS model is formed, and presented in the Figure 2. For building the simulation scenarios iGrafx software was used. Simulation scenarios include simulation of PLC for a one month (March 2014). As a input in simulation, real shipment quantities of the mail classes and different number of workers are used. Each simulation lasted for approximately half an hour and twelve different simulation were performed. During each simulation 7,048,126 mail shipments were simulated. In AS-IS model, every activity is associated with: particular resource which is executing that activity, and with time needed for execution of observed activity. For creating the AS-IS process map basic elements and reasoning of business process modelling is used, and while performing simulations AS-IS process map was fixed (i.e. the interconnections between the elements and the quantity of postal shipments that flow between them). Only parameter that was changing in each simulation was number of workers and their position in AS-IS process map, according to the Table 1. For more details on business process modelling using iGrafx, refer to (Groznik et al., 2008).

Process map for AS-IS model presents four sectors in which incoming mails are processed according to mails type (i.e. mail class). Each mail class has different specificities and requirements for processing. Green color objects represent the generators of mail classes. Mails are then directed to particular sectors, according to their requirements for further processing. Gray color objects represents the activities where time duration of the activities are determined by measuring at the PLC during the vocational training carried out in PLC Novi Sad. Reason for measuring time of execution of activities is because PLC Novi Sad is newly constructed center and Posts of Serbia didn't yet perform measuring and update the official document "Postal Statistics" (Đakovački, 2006), with time durations for the above mentioned activities. Blue color objects represents the activities related with manual sorting of incoming mails, were accepted standard is that one worker sorts the 1000 mails per hour. Brown color objects represent the activities with their time of execution taken from the "Postal statistics" (Đakovački, 2006).

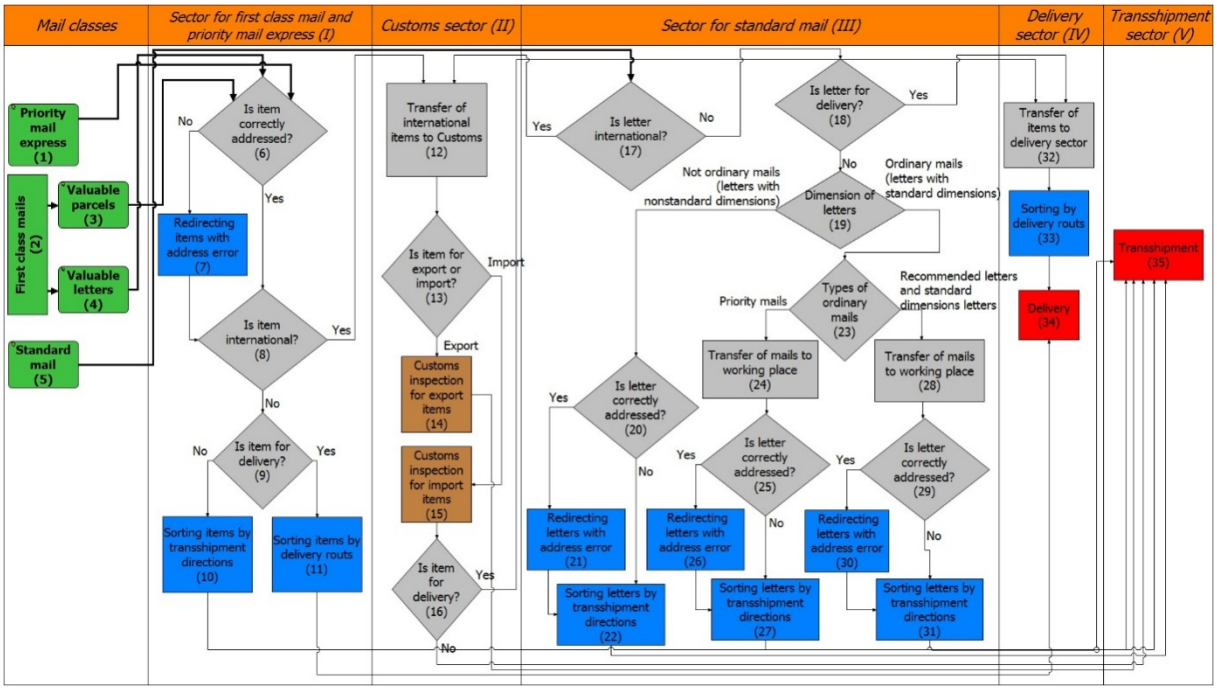

Figure 2. Simulation of current operation conditions in the PLC (AS-IS model)

3.2 Overall mails processing time vs. engaged workers

First step in analyzing the operation capabilities of observed PLC was performing of several simulations with different number of workers in particular sectors in order to determine relationship between engaged workers and processing time of center. Simulations were performed based on several different layouts of workers, and there were twelve different scenarios. Results of simulation, accompanied by different layouts of workers, are presented in Table 1. From Table 1 it is obvious that engaging the different number of workers leads to the different processing time of shipments, bearing in mind the defined workers layout.

Figure 3 presents mentioned relationship, from which we can conclude that processing time is monotonically decreasing with engaging large number of workers. But, from Figure 3 we can conclude that there is a bottom limit, and that drop of processing time with engaging larger number of workers stops at some point. Reason for that is because labor operation capacity has physical limitations, and engaging more and more workers isn't accompanied by significant drop in processing time. Which leads to conclusion that engaging more workers isn't always economically justified, since the decrease in processing time is not big enough, compared with costs related with engagement of additional workers.

Table 1. Simulation results with twelve different layout of workers

Different simulation scenarios	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Support workers	3	3	3	3	3	3	3	3	3	3	3	6
Workers in sector first class and priority mails	8	8	8	8	8	9	9	9	9	12	9	12
Controller	1	1	1	1	1	1	1	1	1	1	1	1
Workers in Customs sector	9	9	9	9	9	10	10	10	10	12	10	15
Workers in sector for delivery	10	10	10	10	11	12	12	13	15	15	18	21
Workers in standard sector	18	20	22	25	26	27	28	30	32	30	36	40
Total number of workers	49	51	53	56	58	62	63	66	70	73	77	95
Average processing time (minutes)	3137	2042	881	232	172	148	70	64	50	57	31	20

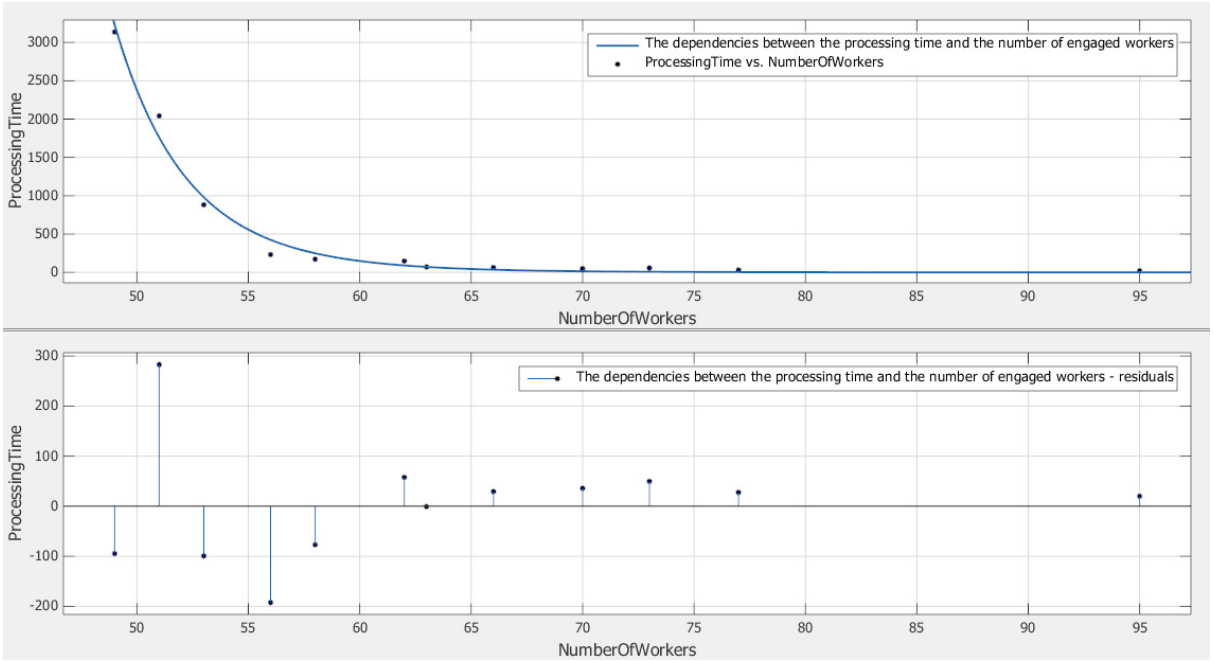

Figure 3. The relationship between the processing time and the number of engaged workers

The dependence of the processing time and the number of workers engaged is numerically estimated by equation (1):

$$f(x) = 1{,}5 \cdot 10^{29} \cdot x^{-15{,}2} \tag{1}$$

Where x is number of engaged workers, and *95%* confidence intervals for coefficients are $(-1{,}3 \cdot 10^{30}; 1{,}6 \cdot 10^{30})$ and (-17,61; -12,8). Equation (1) can be used by managers in order to determine on how big drop in processing time can they expect when they engage different number of workers. This is important, especially in days of peak load, which are days with big increase of incoming mails. PLC have problems in processing this huge amount of incoming mails in small period of time (usually peak load is at the beginning of the month, due to the increase of standard mails shipments). In those days PLC managers need to rearrange workers activities (transfer of workers from other sectors to the sector for standard mails) and engage additional labor force to deal with peak load.

4. CONCLUSION

Efficiency of the executed processes directly affects on overall efficiency of the entire logistics subject. This paper directly deals with this kind of problem. The main research hypothesis in presented paper was to examine the possibility of application of DES on basic postal-logistics processes in PLC. Papers aim was to create framework of PLC in which different simulation scenarios could be performed, in order to test various design solutions on logistic performances of particular PLC. Basically, model can be used for any kind of "what if" analysis, which is from interest for PLC managers. Beside framework, in this paper we also focused on the problem of additional workers engagement and their impact on processing time. As a result we presented the equation (1), derived from simulating the several different workers layouts. Equation (1) can serve to the managers as a guiding tool for deciding how much workers should be included, in which sectors, in order to obtain desired processing time, and in that way fulfill defined level of service.

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REFERENCES

[1] Chan, F. T., Chan, H., Lau, h. C. & Ip, R. W. (2006). An AHP approach in benchmarking logistics performance of the postal industry. Benchmarking: An International Journal, 13, 636-661.

[2] Đakovački, V. (2006). Pravilnik o statistici i normama, Javno preduzeće PTT-saobraćaja Srbija. Beograd: Službeni PTT glasnik.

[3] Kujačić, M., Nikoličić, S., Jovanović, B., Mirčetić, D. (2013). Logistics performance in postal logistics centers. 1st Logistics International Conference, Belgrade, Serbia, 209-214.

[4] Lisec, A., Rihter, A. 2007. Logistical operations in postal logistics centres. Logistics & Sustainable Transport, 1(2), 1-12.

[5] Groznik, A., Kovačič, A., Trkman, P. (2008). The role of business renovation and information in e-government. Journal of Computer Information Systems, 49(1), 80-88.