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SIMLATION OF LINEAR BUSINESS PROCESSES

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Business processes are applied in business organizations, with interconnected and interactively working activities, which convert input into output elements. These are sets of linked and structured activities or tasks that create a specific process outcome. Characteristics of business processes are: definition, orderliness, user knowledge, identification of additional values for users, connection in the organizational structure and functionality of the activity. In a business activity, it is usual to differentiate business processes, production and service processes. Business Process Management focuses on workflow optimization and business process optimization, which usually includes any combination: modeling, simulation, automation, execution, verification and optimization of business activity flows to achieve the goals. Business processes in the new Six Sigma System apply process simulations, which enable rapid checking of the effectiveness and efficiency of the process, with certain levels of trust and risk. Simulation is the imitation of physical and abstract processes or systems, in the real world over time, with a developed model that represents the system itself, with the application of certain analytical and computer techniques. The best known is the computer simulation technique of linear business processes, which is quite detailed here so it can be routinely applied in practice of compressed air flow.

Keywords: Business process. Simulation, Linear business simulation.

INTRODUCTION

Business processes are applied in business organizations, with interconnected and mutually active work activities, which convert inputs into output elements. These are sets of linked and structured activities or tasks that create a specific process result for a given user. The process has the following basic elements: input of the process (materials, energy, information), process management (planning, realization, controlling), process resources (frames, equipment, tools) and process output (semi-product, product, documentation, service). The characteristics of business processes are: definition, have clearly defined entry and exit boundaries, order, consisted of activities that are planned according to the position in space and time, customer knowledge, value- adding), for users who are gaining in the process, embeddedness, which is embedded in the organizational structure and functionality (cross-functionality) of the activity with several different functions, (Popović, 2017). There are many different types of business processes, depending on the character, hierarchy, action, complexity and tradition.

The organization's business is the usual differentiation of business processes, production and service processes. Business processes are usually management processes: managing the organization, managing the quality of process results. Business processes of production are processes of realization: the technology of making and installing or installing process results (services, documentation, product, semi-product). Business processes serving the processes of realization: research market needs to process results, design or creation and development of the process, planning and preparation for implementation of the process, recruitment and training of personnel organization, purchase of materials and equipment for the implementation of the process, input, process and output control

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quality, quality assurance of process results, storage of process results in warehouses, sales and distribution of process results, servicing or maintenance of process results, financial and accounting tasks and securing property of the economic system, (Popović, 2016a; Popović, 2016b).

Organizations in their structure of a regulated system usually have several connected smaller subsystems (sectors, bureaus, drives, warehouses), which usually consist of the following set of 12 subsystems of the organization: IST, market research needs for process results, RUK, management and management of the organization, UPR, quality management of process results, PRJ, design, testing and development of process results, PLA, planning and preparation of process results realization, ZOK, employment and training of personnel of the organization, NAB, procurement and storage of materials and equipment for realization of process results, REA, PRO, sales, storage and distribution of process results, UGR, installation and installation of process results with users, SER, servicing and maintenance of process results, implementation of process results, KON, input, process and output quality control, according to the scheme shown in Figure 1, (Miletić & Ničić, 2016; Popović & Miletić, 2016; Popović et al., 2005).

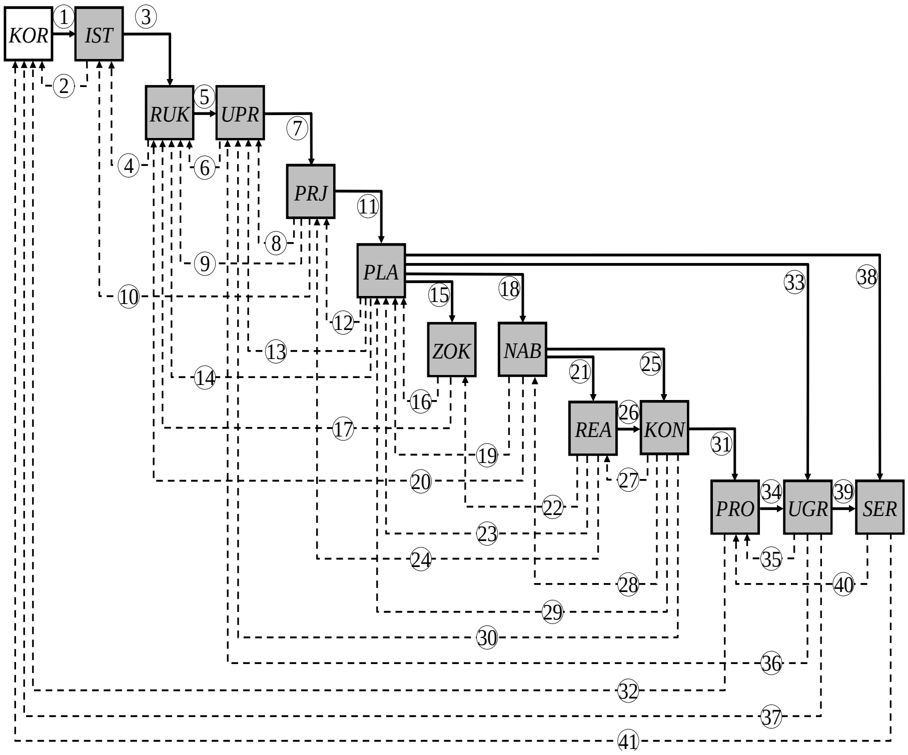


Figure 1: Schema of the system for managing the organization with subsystems

Business Process Management focuses on workflow optimization and business process optimization, which usually includes any combination: modeling, simulation, automation, execution, verification and optimization of business activity flows to achieve the goals of: organization, work system, employees, users and partners, inside and outside the boundaries of the organization. In recent times for business process management, the new Six Sigma System is used, which enables: lowering possible total costs, rational shortening of main and auxiliary times, radically eliminating most of the losses, substantially increasing the quality of the results of the process and increasing the overall profit of the organization. The six-sigma system employs business process simulations that enable rapid checking of the effectiveness and efficiency of the process, with certain levels of trust and risk (Popović & Nikodijević, 2015; Popović et al., 2014). Simulation is the imitation of the work of physical and abstract processes or systems, in the real world over time, with a developed model that represents the system itself, with the application of certain analytical and computer techniques.

Analytical techniques for simulating business processes are technical procedures for solving complex problems without the use of computers, using ordinary calculators.

Computer techniques for simulating business processes are special procedures for analyzing complex problems with computers that typically include procedures for simulating business processes in available computer programs: Solver/Microsoft Excel, RNG/Microsoft Excel, Monte Carlo/RiskAmp, Minitab, Predictor/Crystall Bal, OptQuest/Crystall Bal, ExendSim, etc., (Popović, 2017). The best known is the computer simulation technique of linear business processes with the Solver/Microsoft Excel computer software, which will be presented in more detail here, so that it can be routinely applied routinely in everyday practice of the organization.

LINEAR BUSINESS PROCESSES

Linear business processes can be described with linear algebraic equations and inequalities, in which each term is either a constant or product of a constant and a variable size. Existing linear relationships allow the application of Linear programming or optimization, with a mathematical model that yields the best (optimum) results with a maximum or minimum output, (Laguna & Marklund, 2013; Popović & Ivanović, 2011; Hillier & Lieberman, 2010). Any linear equation with n unknown sizes can be written in a table, matrix or parameter form, but most often as:

$$a_1x_1 + a_2x_2 + \dots + a_nx_n = b, \tag{1}$$

where:

$a_1, a_2, .., a_n$,	numbers (coefficients),
$x_1, x_2, .., x_n$,	unknown variables (factors, *x*, *y*, *z*),
b,	constant.

If all the coefficients are equal to zero, then $b \neq 0$ and the equation is not a solution or $b = 0$, and each set of values is an unknown solution. If $n = 2$, the set of solutions is in the two-dimensional plane, and if $n = 3$, the set of solutions is in a three-dimensional space, (Kirchmer, 2011; Ragsdale, 2011). The standard form of the mathematical model of the linear programming problem consists of the following three parts: the criteria (maximizing or minimizing), the linear or nonlinear equations of the linear type and the existing constraints. In particular, the practical application of the Simplex method of linear programming is performed with the final sequence of iterative steps, beginning with a certain basic solution, (Laguna, 2011; Popović et al., 2008).

The problem of solving the linear inequality system dates back to 1827, when French mathematician Jean-Baptiste Joseph Fourier (1768-1830) published a method for solving them. The general problem of linear programming was given by Russian mathematician Leonid Vitalevich Kantorovich (1912-1986), the winner of the Nobel Prize in 1975. In 1948, the simplex linear programming method was independently developed by George Bernard in an unpublished report "Theory of Linear Inequalities".

In the practice of organizing organizations, the application of the Simplex-Non Linear Programming Method is most often encountered in the following group tasks in simulation of optimal planning:

1. maximizing quantities (the capacity of the production or service organization, the quantity of products in the production program, the number of work activities of the organization)
2. maximizing profits (profits of production or service organization, profits in the organization's activities, profits in possible variants of investments),
3. maximizing the time (waiting for the organization's work activities, the time of holding the material or the equipment in the warehouses, the time to extend the delivery of products or services),
4. minimizing distance (distance between organization's workplaces, distances between transport routes, distances between critical parts of products or services),
5. minimizing costs (production or service costs of the organization, costs of delivery of products to users, costs of purchasing materials or equipment),
6. minimizing the time (time of work of the organization, the time of delivery of products or services, the time of keeping the material or equipment in the warehouses,
7. distribution of quantity (quantity of mass, energy or information in the organization's activities, amount of critical tasks available to the workers available)
8. distribution of profits (profits by production units of the organization, profits by executives),
9. time distribution (time of production or service activities in organizations, time of delivery products or services), etc.

METHODOLOGY OF PLANNING THE OPTIMAL DISTRIBUTION OF QUANTITIES

Simulation of the process of planning the optimal distribution of quantities, (Chang, 2006), allows determination of the highest compressed air flow (m3), from a certain air compressor S (start), through the available flow valves (A, B, C, D, E) and their mutual and the length of tube (m) consumer F (finish) according to the scheme in Figure 2.

Simulation of the optimal distribution planning process, using the Solver/Excell computer software, (Evans & Olson, 1998), enables the application of the following 11 simple steps:

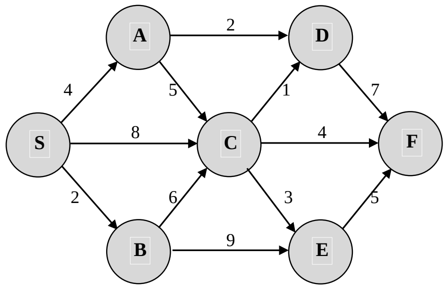
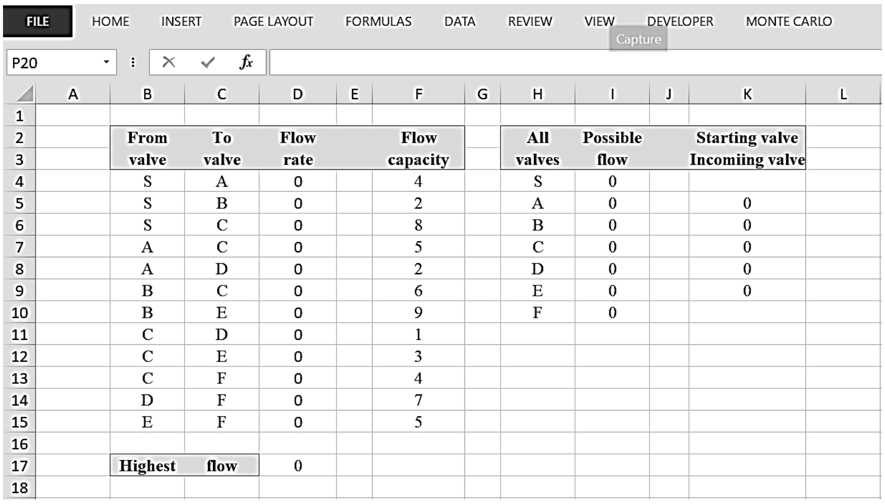


Figure 2: Valve diagram and their length of tube

Step 1: Run Excel software to write known data in the task you received as shown in Figure 3,

Step 2: Detect the table cells: from the valve (B4: B15) to the valve (C4: C15), the flow (D4: D15), the capacity (F4: F15), the starting valve / incoming valve (K5: K9) and the expected total flow (D17),



	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		From	To	Flow		Flow		All	Possible		Starting valve	
3		valve	valve	rate		capacity		valves	flow		Incomiing valve	
4		S	A	0		4		S	0			
5		S	B	0		2		A	0		0	
6		S	C	0		8		B	0		0	
7		A	C	0		5		C	0		0	
8		A	D	0		2		D	0		0	
9		B	C	0		6		E	0		0	
10		B	E	0		9		F	0			
11		C	D	0		1						
12		C	E	0		3						
13		C	F	0		4						
14		D	F	0		7						
15		E	F	0		5						
16												
17		Highest	flow	0								
18												

Figure 3: Starting simulation table

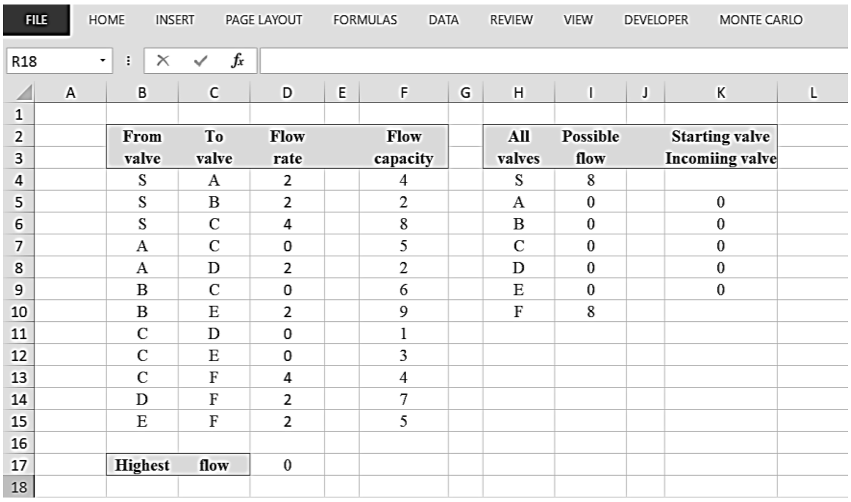
Step 3: Enter the following functions for the application of the resolution process:
=SUMIF(B4:B15,H4,D4:D15) in the cell I4,
=SUMIF(B4:B15,H5,D4:D15)-SUMIF(C4:C15,H5,D4:D15) in the cell I5,
=SUMIF(B4:B15,H6,D4:D15)-SUMIF(C4:C15,H6,D4:D15) in the cell I6,
=SUMIF(B4:B15,H7,D4:D15)-SUMIF(C4:C15,H7,D4:D15) in the cell I7,
=SUMIF(B4:B15,H8,D4:D15)-SUMIF(C4:C15,H8,D4:D15) in the cell I8,
=SUMIF(B4:B15,H9,D4:D15)-SUMIF(C4:C15,H9,D4:D15) in the cell I9,
=SUMIF(C4:C15,H10,D4:D15) u ćeliju H10, =I4 in the cell D17,

Step 4: Entering the 1st Probe Scheduled Quantities: via the valveSADF, SCF and SBEF according to Figure 4,

Step 5: Obtaining the 1st solution in D17 cell by activating the Enter function in Figure 5, (flow = 1 ÷ 9, no flow = 0) with a possible maximum flow of 8 m3 as shown in Figure 6,

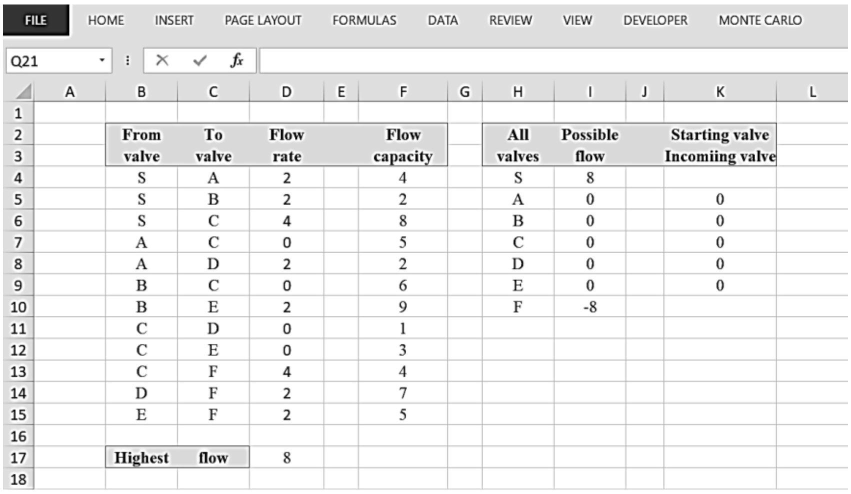
Step 6: Activate the Solver function at the right end of Figure 7 to get an optimal but not possible solution,

Step 7: Activate the Add function in the displayed window (Solver Parameters) to enter the first necessary parameters (I5:I9=K5:K9) into the subject to the Constraints window, with the OK activation in Figure 8.



From valve	To valve	Flow rate	Flow capacity	All valves	Possible flow	Starting valve Incomiing valve
S	A	2	4	S	8	
S	B	2	2	A	0	0
S	C	4	8	B	0	0
A	C	0	5	C	0	0
A	D	2	2	D	0	0
B	C	0	6	E	0	0
B	E	2	9	F	8	
C	D	0	1			
C	E	0	3			
C	F	4	4			
D	F	2	7			
E	F	2	5			
Highest	flow	0				

Figure 4: Entered 1st test with valves SADF, SCF and SBEF



From valve	To valve	Flow rate	Flow capacity	All valves	Possible flow	Starting valve Incomiing valve
S	A	2	4	S	8	
S	B	2	2	A	0	0
S	C	4	8	B	0	0
A	C	0	5	C	0	0
A	D	2	2	D	0	0
B	C	0	6	E	0	0
B	E	2	9	F	-8	
C	D	0	1			
C	E	0	3			
C	F	4	4			
D	F	2	7			
E	F	2	5			
Highest	flow	8				

Figure 5: Obtained solution of the highest flow in the 1st prob

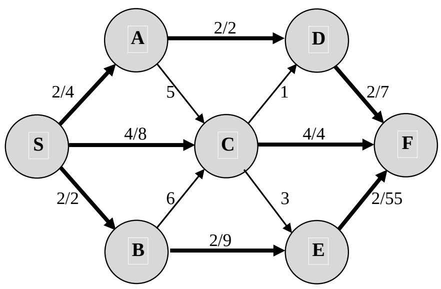


Figure 6: Obtained solution of the highest flow in the 1st prob with the valves SADF, SCF and SBEF

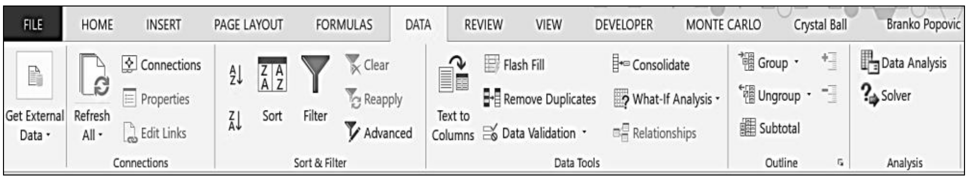


Figure 7: Activating the Solver function

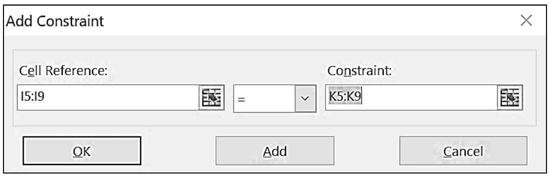


Figure 8: Activating the function of the functions (Add)

Step 8: Activate the Add function in the displayed window (Solver Parameters) to enter the required restriction parameters (D4: D15<= F4: F15) in the subject to the Constraints window, with the OK activation in Figure 9.

Step 9: Enter the required parameters: D17, Max, D4: D15, Make Unconstrained Variables Non-negative, Simplex LP) in the window (Solver Parameters) in Figure 10, with the activation of Solve,

Step 10: Solver Results for saving the optimal solution, where you can select the options (Keep Solver Solution) and (Sensitivity) in Figure 11. with the activation of OK,

Step 11: An optimal solution for optimal distribution of compressed air is obtained: through SADF, SCF, SBEF, SCEF, SACEFand SACDFwith an optimum (maximum) flow of 12 m3, in Figure 12.

Step 12: therefore, in order to achieve optimal compressed air flow, from compressor S to consumer valve F, the resulting solution with a maximum flow of 12 m3 according to Figure 13 should be planned.

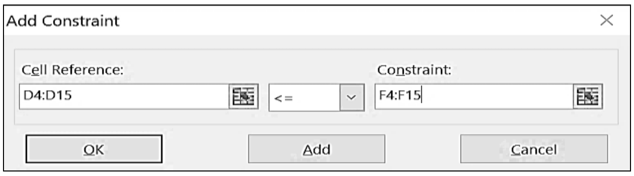


Figure 9: Activate the Add function

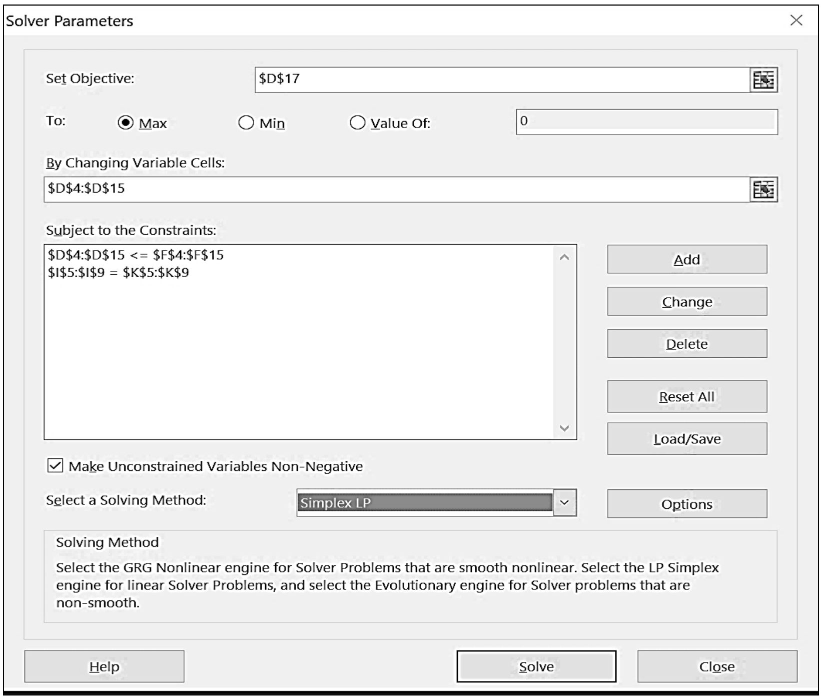


Figure 10: Entering functions to obtain an optimal solution

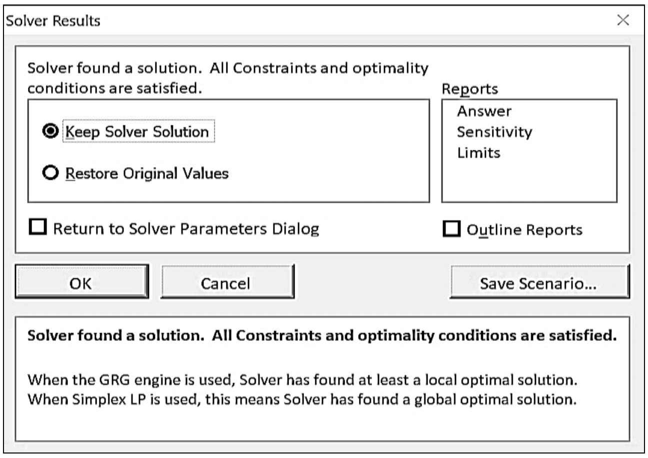
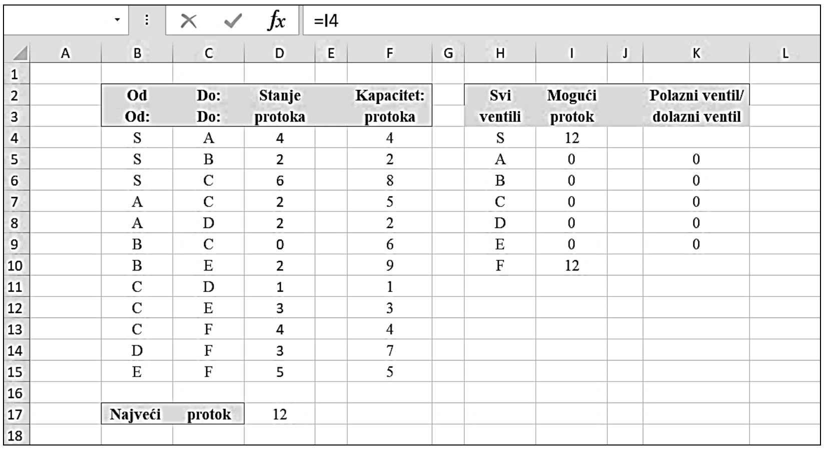


Figure 11: Window for saving the solution obtained



=I4

Od Od:	Do: Do:	Stanje protoka	Kapacitet: protoka	Svi ventili	Mogući protok	Polazni ventil/ dolazni ventil
S	A	4	4	S	12	
S	B	2	2	A	0	0
S	C	6	8	B	0	0
A	C	2	5	C	0	0
A	D	2	2	D	0	0
B	C	0	6	E	0	0
B	E	2	9	F	12	
C	D	1	1			
C	E	3	3			
C	F	4	4			
D	F	3	7			
E	F	5	5			
Najveći	protok	12				

Figure 12: The solution obtained by the optimal solution procedure

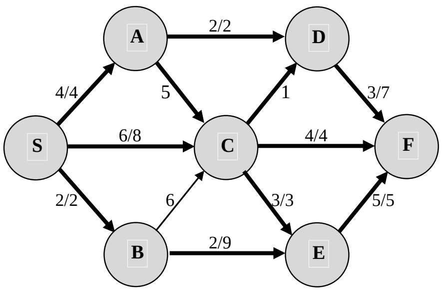


Figure 13: The optimal flow with the valves SADF, SCF, SBEF, SACF, SACDF, SBCF and SBCEF

RESULTS

The resulting first solution in this example allows for a possible flow of only 8 m3 through the valves SADF, SCF, SBEF, SCEF, SACEF and SACDF with 4 unused tubes AC, CD, BC and CD. The optimal solution allows for a maximum flow of 12 m3, via the SADF, SCF, SBEF, SCEF, SACEF, SACDF valves, with only one unused BC tube.

This example effectively illustrates the simulation of optimal quantization planning, using the Simplex method of linear programming. However, this example can also apply to the following groups of different tasks: maximizing profits, maximizing time, minimizing distance, minimizing costs, minimizing time, distributing quantities, distributing profits, distributing time, etc.

DISCUSSION

Business processes are applied in business organizations, with interconnected and mutually active work activities, which convert inputs into output elements. These are sets of linked and structured activities or tasks that create a specific process outcome. In the business activity, it is usual to differentiate business processes, production and service processes. Business Process Management focuses on workflow optimization and business process optimization, which usually includes any combination: modeling, simulation, automation, execution, verification and optimization of business activity flows to achieve the goals of: organization, work system, employees, users and partners, inside and outside the boundaries of the organization.

Business processes in the new Six Sigma System apply process simulations, which enable rapid checking of the effectiveness and efficiency of the process, with certain levels of trust and risk. Simulation is the imitation of physical and abstract processes or systems, in the real world over time, with a developed model that represents the system itself, with the application of certain analytical and computer techniques. The best known is the computer simulation technique of linear business processes, which is quite detailed here and can be routinely applied in practice.

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SIMULACIJA LINEARNIH POSLOVNIH PROCESA

Poslovni procesi se primenjuju u poslovnim organizacijama, uz međusobno povezane i interaktivne radne aktivnosti, koje pretvaraju ulaze u elemente izlaza. To su skupovi povezanih i strukturisanih aktivnosti ili zadataka koji stvaraju specifične ishode procesa. Karakteristike poslovnih procesa su: definicija, regularnost, korisničko znanje, identifikacija dodatnih vrednosti za korisnike, povezivanje u organizacione strukture i funkcionalnost aktivnosti. U poslovanju, uobičajeno je razlikovanje poslovnih, proizvodnih i uslužnih procesa. Upravljanje poslovnim procesima se fokusira na optimizaciju upravljanja i optimizaciju poslovnih procesa, koje obično uključuju kombinacije: modeliranja, simulacije, automatizacije, izvršenja, verifikacije i optimizacije tokova poslovnih aktivnosti, radi postizanja ciljeva. Poslovni procesi u novom Sistemu šestsigma primenjuju simulacijeprocesa, koje omogućavaju brzu proveru efektivnosti i efikasnosti procesa, sa određenim nivoima poverenja i rizika. Simulacija je imitacija fizičkih i apstraktnih procesa ili sistema, u stvarnom svetu tokom vremena, sa razvijenim modelom koji predstavlja sam sistem, koristeći određene analitičke i računarske tehnike. Najpoznatija je računarska simulacija linearnih poslovnih procesa, koja je ovde detaljno opisana i koja se rutinski primenjuje u industrijskoj praksi,npr.raspodele komprimovanog vazduha.

Ključne reči: Poslovni proces, Simulacija, Linearna poslovna simulacija.