A SIMULATION STUDY OF THE ORGANIZATION FOR EMPLOYMENT OF WORKFORCE IN GREECE

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Abstract

The principal aim of this paper is to depict the consequences of the current sociopolitical situation in Greece, on the functions of a crucial organization of public sector. This was feasible through a simulation study of a branch of the Organization for Employment of Workforce (OEW), which is the organization of the public sector responsible for employment. OEW was selected for the present study because of the functional problems that faces, due to both international and national economic crisis. The objective was to study and model the long waiting queues and the time delays during the allowances given. Discrete event simulation implemented with the simulation software SIMUL8, offered a comprehensive and flexible framework for modeling and experimentation. The system was divided into separate and parallel subsystems, some of them interdependent with each other, that were described by Activity Cycle Diagrams. Statistical analysis of the results obtained from the SIMUL8 model was performed, as well as for validation and verification techniques were applied on the model. Finally, hypothetical scenarios concerning the operations of the organization were conducted. The simulation model provided strong justification that waiting queues were dependent on the number of employees, the number of days waiting for the allowance and the arrival rates of citizens.

Keywords: Simulation, Modeling, Simul8, Organization for Employment of Workforce, Economical Crisis.

Presenting Author's biography

Aikaterini Spyropoulou got her Diploma as an Electrical and Computer Engineer from Polytechnic University of Democritus University of Thrace and the M.Sc. in Informatics and Management. She worked for 1.5 years in the Organization for Employment of Workforce and she is currently collaborating with the Department of Informatics, Aristotle University of Thessaloniki. Her research interests include operational research and simulation techniques in management.

1. Introduction

The current economic crisis, in both national and international level, has caused many severe social problems. The most profound impact is on businesses and workforce. It is a fact that the number of redundancies has been increasing during the past year and, inevitably, the number of unemployed people has risen too. The statistical evidence showed that in February of 2010 there were about 1.037.500 registered citizens in the organization that represent the 9.50% of the population [1]. Also, it is foreseen that by the end of 2010 the youth unemployment rate in Greece will be close to 28% [2]. The Institution responsible for workforce is the Organization for Employment of Workforce (OEW), which is a public interest organization, run by the state towards the citizens' benefit. The strategic goals of the Organization are mainly focused on three sections: (i) the education and training of workforce, (ii) the collaboration between labor supply and demand, and (iii) the provision of allowances and benefits.

The main topic of research is the provision of allowances, where the Organization wants to deal with the long waiting queues and time spent during the decision making about the allowances / benefits to be given. This study is about the procedures related to the public, because that is where the biggest problems occur, whereas it does not analyze the inner functions of the Institution.

The Organization has 139 branches for job promotion and allowances' provision and 128 branches of education and training centers [3]. The Organization's branch in which the research was applied is the Centre of job promotion in Thessaloniki, placed in 10^{A} Dodekanisou Street, in the centre of the city. This branch is the biggest one in the city, serving more citizens than all the other branches of the Institution in the prefecture of Thessaloniki.

2. Problem definition

A thorough review of business's processes indicates that Discrete Event Simulation has been widely applied. The main areas of research are restricted to decision making in military applications, economic studies, health systems, computer systems design, construction, transport and even social analysis. The history in simulation in sociology is extended to specific areas such as system dynamics, cellular automata, iterated game theory, distributed artificial intelligence, neural networks, multilevel simulation, simulation of social networks and organizations and policy-oriented tax-benefit microsimulation [4]. However, a research gap is spotted in the management of businesses of public interest. The services provided by these businesses are produced in the presence of the "customers", i.e. people concerned for allowances. Customers get involved in the processes and this could confuse the limits between employees and customers. Also, the difference from other business processes is that changes in the quality of services happen by incontrollable factors, irrelevant to both customers and owners [5]. In addition to that, the situation in public services in Greece is so unique, that the international literature is difficult to find areas of applications in such circumstances.

The OEW is an organization of public benefit and its operation is under the supervision of the Greek Ministry of Employment and Public Protection. To the best of our knowledge, there has never been any attempt to model and simulate its procedures in order to optimize its functionality, the quality of provided services and the performance of its employees. Nevertheless, due to its crucial economic, social and political role, there have been attempts to improve the system, based mainly on the experience and the pressure for upgrading applied by each government.

There are several issues concerning the public services of OEW that deserve investigation within an operational research framework. These are connected with problems in the functionality of the organization. Some of them are:

- Long waiting queues and therefore long delays, causing people to literally wait on the street pavement outside the building in order to be served.
- Lack of permanent employees, who could fill in the service gaps of the Institution and replace others who may be absent for either short or long time periods.
- Delays in publishing the decisions, beyond the managerial estimated time.
- Lack of efficiency to face emergency situations, like during the Christmas period in 2009 when allowances of solidarity had to be provided.

The present simulation study is an attempt to describe the system systematically, as a model in order to determine and measure various functional characteristics such as the time needed for service and the length of the waiting queues and also, estimate the most suitable number of employees to be serving the public, calculate the minimum time needed for the publishing of decisions and benefits, execute hypothetical scenarios of functioning and locate and analyze the crucial factors of serving the public in the Institution. All these goals of the study are closely related to the impacts of the economic crisis since the system gets more and more overloaded and therefore the actions for service improvements are absolutely necessary.

3. Methodology

The methodology implemented in this study is based on the algorithm in Fig. 1 [6], where some steps were executed once and others more than once. In this

paper only a short insight can be provided, due to the limited space.

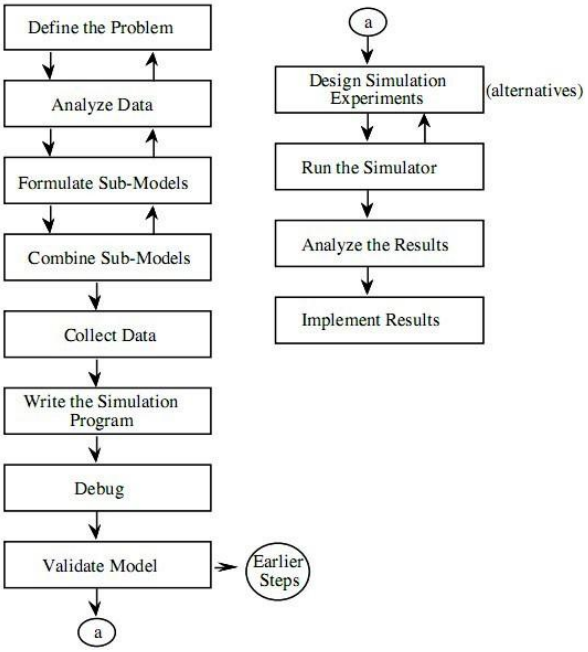

Fig. 1: Basic steps in a simulation study [6]

The software package chosen for the purposes of this simulation was SIMUL8® [7], which is used by the majority of the academic users [8], mainly for its editing capabilities, the animated processes and the visualization of the results [9]. Furthermore, where necessary, statistical analysis was conducted, using the statistical package SPSS® [10]. After the problem definition, seven phases were conducted which could be described as follows: 1. system description with data analysis, 2. model development which consists of the building and combination of the system's sub-models, 3. collection of input data, 4. implementation of the simulation model, 5. collection of results, 6. verification and validation of both model and results and 7. designing simulation experiments and analyzing scenarios' results.

3.1 System description

The objective was to study the procedures which involve customers. Note that the description "customers" is technical and refers to individual citizens waiting to be served. We are particularly interested in their course from the moment they enter the Organization to apply for an allowance, to the moment when the corresponding procedure is complete and the clients leave the system. The classification of the procedures was made according to whether the customer was unemployed or employer / employee.

The procedure of all the allowances and benefits provided by the Organization is the following: the customer enters the authorized office, waits for his/her turn and the employee serves him/her by filling the application forms and attaching the necessary supporting documents. After the customer leaves, the responsible employee checks the documentation in order to decide whether the customer is entitled to the allowance or not. The customer returns after several days to be informed about the outcome of his allowance and if there are no other obstacles, he/she starts receiving the monthly payment. The allowances for employers / employees are serial independent procedures, providing one single payment at the completion of the allowance. On the contrary, the allowances concerning the unemployment are complicated and interdependent procedures, which first demand the publication of an unemployment card. Afterwards, several monthly renewals of the card need to take place, before the beginning of the allowance's provision. Also, according to the allowance, there might be more than one payment.

The allowances under consideration which used to classify the customers in the corresponding categories are:

- *Unemployment*: Allowance for the unemployed people having at least two years of continuous occupation before their dismissal.
- *3months*: Allowance for unemployed people, who are without a job for at least three months and they cannot get the unemployment allowance.
- *13days*: Allowance for those who finished their unemployment payments and are still without a job for a month.
- *Released from jail:* Allowance for ex-prisoners who were employed before jail.
- *Long term unemployment*: Allowance for unemployed people over 45 years old, being without a job for over a year.
- *19-29 years old:* Allowance for young people being without a job for over a year.
- *Maternity*: Allowance for women who have recently gave birth.
- *6months maternity*: Allowance for mothers who have finished the maternity allowance and are currently employed.
- *Students' leaves*: Allowance for university students who take leaves from their work to participate in the semestral examination of their universities.
- *Occupation of disabled people*: Allowance for employers who have disable people in their businesses.
- *Training technical graduates*: Allowance for employers who train graduates from technical schools.
- *Job availability*: Allowance for employees who are unemployed for a few days but have not got dismissed.

- *Company's retention*: Allowance for employees whose employers cannot provide salaries.
- *Commitment*: Allowance for employees being called by the army.
- *Interruption*: The procedure for altering or interrupting the unemployment allowance
- *Consultants*: The procedure where unemployed people fill the application forms in order to find a job.
- *Dismissal/recruitment*: The procedure where the dismissal / recruitment paper gets a protocol number.
- *Seasonal*: Allowance for employees being occupied per season, i.e. hotel workers.
- *Family*: Allowance for employees with children.
- *Special economic assistance*: Special allowance given once a year.
- *Subsidized programs*: Programs for employers, sponsored by the European Union

3.2 Model building

The system was divided into separate and parallel subsystems, some of them interdependent with each other. In this system the entities have two forms: the application which is edited by the Organization's employers and the customer who enter and leave the system more than two times.

Each of the subsystems was modeled with the Activity Cycle Diagrams (ACD), which illustrate the main entities and their mutual interactions. ACDs are one way of modeling the interactions of system objects and are particularly useful for systems with a strong queuing structure [11]. ACDs have the advantage of parsimony in that they use only two symbols which describe the life cycle of the system's objects or entities [11]. The green colored squares illustrate the "active state" where the collaboration of different classes of entities takes place and the red colored cycles illustrate the "dead state" where the entity is waiting. Fig. 2 demonstrates the two situations described above.

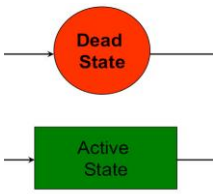

Fig. 2: The two possible situations of entities

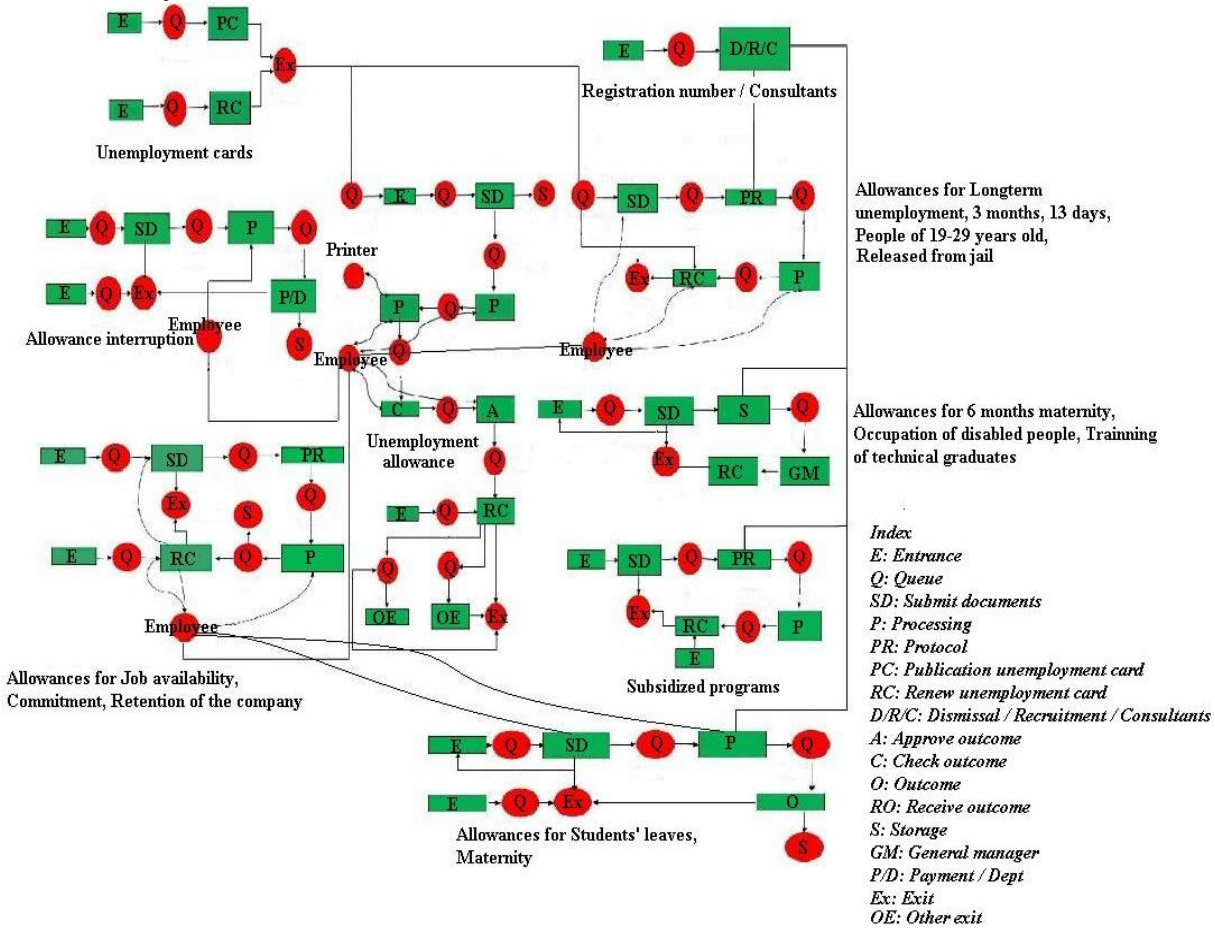

Fig. 3: The activity cycle diagrams of the allowances

The procedures according to the ACD are shown in Fig. 3, 4, where in Fig. 3 the allowances and benefits that occur the whole year, are shown and in Fig. 4 the allowances and benefits that occur only for 2 to 4 months per year.

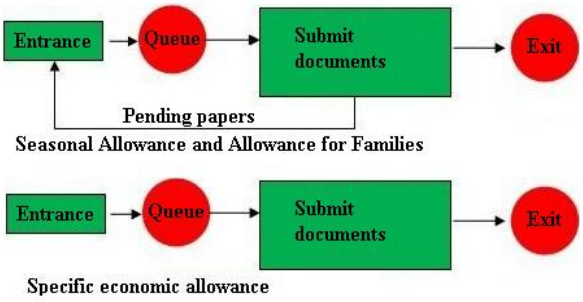

Fig 4: The activity cycle diagram for the seasonal allowance, for families and the special economic allowance

Because of the complication of the system and the limited space, there are some simplifications in the system, i.e. each step of each procedure is symbolized as shown in the index. Each employee is responsible for more than one allowance, so the grouping of the allowances is based on the employees working there. As a result some employees are considered as resources for the system, with the hardware, i.e. printers, the protocol and the other businesses that collaborate with the OEW for some allowances. Furthermore there is always an employee to serve the customer, either the allowance's sector is within his duties or not. The OEW serves only customers included in the geographical area covered by this branch.

Several assumptions were made during the model development. First, the information system of the OEW has three main servers that were always available. Second, FIFO queuing was followed in the processing of all the applications, and, third, there was infinite storage space.

3.3 Input data

The collected data concern the services' rates of the Organization's employees and the rates of customer arrivals in the Organization. The software in which the simulation was implemented is powerful enough and capable of building a model based only on these data. Since it is the first time that a simulation study of all the services is conducted, there were no specific data for the rates of arrivals and service, even though some departments were completely computerized. As a result, new data were collected where it was possible, for the period of one year. In cases when this was not possible, the data used were based on several observations during the year, and then confirmed and completed by the observations of the employees themselves. One exception is the entrance for the unemployment allowance, for which there were available data concerning the past 2.5 years. Note that the Institution is open from 8:00 to 16:00 every day, but available to the public from 8:00 to 13:30. This means that the distributions used for the simulation of the arrival rates are timely dependent and get altered after 13:30. Finally, the time measure used for the simulation is the day, and so the variables of the simulations are expressed in days.

3.4 Simulation model

The simulation model was substantiated with SIMUL8® and represented by the activity cycle diagram in Fig 3 and 4.

There are 21 entrances in the system for the allowances respectively. 14 of them are independent, whereas 7 of them begin from the unemployment card and end in different allowances. The entities were separated by labels and the routing was defined by commands in visual logic, supported by the software.

The entities of the system have two forms: the application form and the customer. The entity – customer enters the system, after its interaction with the employee the entity – application form is created; then the two forms follow different routes and finally reunite when the customer gets informed about the outcome of his/her allowance.

3.5 Results

The special feature in the present simulation is the parallel development of the majority of allowances, so each allowance was tested separately. The results' collection period was 270 working days annually with the warm – up period set at 50 days. The simulation model run for 100 times for each allowance and with 50 different set of numbers for its stochastic characteristics. The simulation time unit was the day and the opening hours were 8 hours per day.

The employees are occupied in more than one allowance, so the grouping of the procedures was based on that fact. Despite the multi-occupation in many allowances, the results show that some employees were underemployed, because they had small percentages of employment. On the contrary, in the allowances for *unemployment*, for *families*, the *seasonal allowance* and the *special economic allowance*, there was need for additional staff. Fig. 5, shows the percentage of occupation in *seasonal, special economic* and *family* allowances, respectively, where green indicates the working and yellow the waiting percentage of employees.

Fig. 5: The utilization in employees of seasonal, special economic and family allowances.

Also, it was proved that the length of the waiting queues depended on the arrival rates, the number of

employees, the time passed until the publication of the decisions for the allowances and the number of customers being served the days of these publications. The average time in simulation varied from several minutes to 60 days. Despite this, the maximum time in system was very high in some allowances because customers may have some documents missing. In that case their applications are pending until they submit the necessary documents. Two typical times in simulation graphs are shown in Fig. 6 and 7. Fig. 6 shows the average time in simulation in *consultants* where it seems that there are not any waiting queues. On the contrary Fig. 7 shows that customers should wait 58 days to receive the outcome of their applications for the allowances of *occupation of disabled people* and *training technical graduates*.

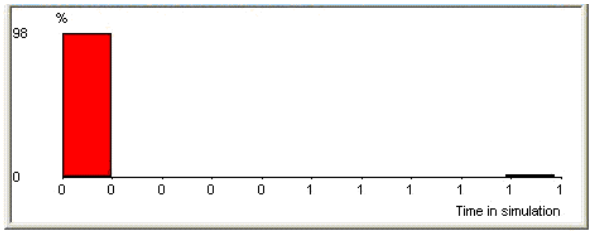

Fig. 6: The average time in days in the consultants

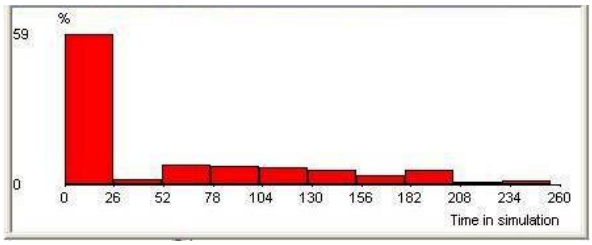

Fig. 7: The average time in days in occupation of disabled people and training technical graduates allowances

Furthermore, in the allowances, where the number of customers is extremely high for the time being provided, the incoming entities were from customers individually, as well as from other public services being cooperated with the Organization.

3.6 Verification and validation of the model

The quality of a simulation model consists of three concepts: the content, the process and the outcome of a simulation study [12]. This is feasible with validation and verification techniques for each modeling step and its results. Therefore a procedure model is required that defines verification and validation related activities for each single modeling step and its results [13].

The verification and validation needed for every phase were conducted with several typical tests after each step. The animation was helpful through the entire process, as well as the monitoring. At the problem and the system description several reviews were reported, so that the employees could revise the system. Afterwards at the model development's phase, sub model testing took place conducting extreme condition tests. Finally, at the phases of simulation model and results, statistical techniques, consistency tests and extreme condition tests were applied, all supported by the simulation software. Interviews with the employees were conducted and then the results were compared to the given ones. Tab. 1 shows the results of the simulation, the given data and their deviations, grouped in two main categories: employment and unemployment allowances. The results indicate the number of customers in one year.

Tab. 1: The results from the simulation and the given data

Results	Simulation	Data	Deviation
Entrance Unemployment	41964	42025	0.14%
Exit Unemployment	30055	30370	1%
Entrance Employment	32004	31780	0.7%
Exit Employment	27551	27140	1.5%

The results show that the deviations between the simulation results and the data provided by the employees are so small that they can be considered as insignificant.

Also, the main parameters affecting the performance of the model were examined. Sensitivity analysis was used, which is the process of testing the significance of the data input parameters and observe their effects on the system. Two tests were set-up to evaluate the impact of the arrival rates to the number of customers being served (informed about the outcome of the allowance) and the average time in simulation, which were the performances measures. Specifically, Tab. 2 shows the impact on time in simulation and Tab. 3 on the number of customers when the distributions of the arrival rates got a higher and a lower value than the usual. The symbol "-" means that there was no change in the results; whereas the symbol "+" means that there was a significant change. It should be noted that the changes in the time in simulation were spotted by the corresponding graph from the simulation software, and so the impacts were represented by symbols and not numbers.

As Tab. 2 and 3 show, the majority of results were sensitive to the alterations of the distributions of the arrival rates. There were very few cases where no changes were observed. That is because the impacts on the performance measures were irrelevant to the input parameters but responsive mainly to the service parameters, such as the collaborations with other businesses and the service rate of the employees. However, the majority of the results of the simulation were confirmed since the entrance affects the system.

Tab 2: Sensitivity analysis result measuring the time in simulation

Allowance / Benefit	Impact on time in system	
	Test 1	Test 2
New unemployment card	-	-
Unemployment	-	+
Maternity	+	+
Student leaves'	+	+
6months maternity	+	+
Training technical graduates	+	+
Occupation disabled people	+	+
Family	-	-
Seasonal	+	+
Special economic assistance	+	+
Consultants	-	-
Dismissal/Recruitment	+	+

Validation deals the assessment of behavioral or representational accuracy of the model [14].It is the procedure in order to prove that the model, which was created with its simplifications, behaves with satisfactory accuracy consistent to the study objectives. The results of the simulation were compared with the real ones. Also, the software provided the statistical analysis, i.e. confidence intervals needed for the validation of the model, so no further analysis was conducted. The Central Limit Theorem was applied to the exit of the allowances. The majority of the exits followed the normal distribution [15], so the model is considered to be valid.

Tab 3: Sensitivity analysis result measuring the number of customers being served

Allowance / Benefit	Standard results	Impact on customers being served	
		Test 1	Test 2
Renew card	5792	7072	4355
13days	1440	1460	1240
3months	1440	1580	1420
Released jail	1440	1580	1420
19-29 years old	44	37	62
Long term unemployment	44	37	62
Job availability	221	221	221
Commitment	221	269	198
Company's retention	221	250	203

3.7 Conducting scenarios

The factorial experimental design was conducted in order to check hypothetical scenarios about the anticipated changes in the Organization. The number of customer exits the system and the average time in the system were monitored in relation to the four critical factors previously mentioned. Each factor had three possible values: the simulation one, a smaller one and a bigger one. Then, with the aid of the orthogonal design, different sets of experiments took place. The last step was the statistical analysis with the analysis of variances (ANOVA). The ANOVAs were drawn for all the allowances. All of the results, the number of customers and the average time in system, expressed by the four independent critical factors: arrival rate, number of employees, duration until the publication of the decisions of the allowances made and number of customers being served the days of these publications. Depending on the results of each allowance different combinations were observed. The Eq. (1) expresses the general form of the regression analysis of ANOVAs, where:

'a': constant variable and

'b','c','d','e': constants of the critical factors

Arrival rate: variable of the distribution of arrival rate at the allowance

Number of employees: number of employees serving customers at the allowance

Duration days until outcome: how many days should pass until the final outcome of the allowance is officially announced to the customer

Number of customers being served at the outcome days: how many customers enter the system at the day of information about the outcome of their allowance

$$\begin{aligned} &Customers\_getting\_allowance\,/\\ &Average\_time\_in\_system =\\ &a + b*Arrival\_rate + c*Number\_of\_emlpoyees\\ &+ d*Duration\_days\_until\_outcome\\ &+ e*Number\_of\_customers\_being\_served\_\\ &at\_the\_outcome\_days \end{aligned} \quad (1)$$

Nevertheless, the model described adequately from 16.4% to 68% of cases, depending on the allowance. The highest percentages appeared in the allowances for *maternity, students' leaves, 6months maternity*, where the arrival rate was the main critical factor, but the duration until the publication of the decisions had little influence. This is proved by the constants: a=34.9, b=4.53 and d=0.914. Also in the allowances for *training technical graduates* and *occupation of disabled people*, the main critical factor was the number of customers being served at the publication days and there was negative correlation (which expressed by the negative sign in the constants) between this and the average time in system, since a=134.24, b1(arrival rate of technical training)=3.93, b2(arrival rate of disabled people)= -26.94 and e=-1.7. On the other hand the poorest regression results were on the *unemployment* allowance, where the R-square

was only 16.4%. The most interesting scenario in the orthogonal design was the one that combined the increase in the arrival rate, the decrease in the number of customers being served at the publication day and the duration days until the publication. In that case the number of customers being served at the publication day was increased by 21.83%. The allowances of *13days, 3months* and *released from jail* had poor results. In these allowances the R-square was only 21.6%, but it was proved that the number of employees had no impact on the allowance. Another interesting regression appeared in the *long term unemployment* and *in 19-29 years old* allowances, where the number of customers being served at the publication day was only proportionate to the arrival rate, so the simple equation had a=28.667 and b=16.

4. Conclusion

The experience gained by this research outlined a number of advantages in the decision making for public interest organizations. The Organization for Employment of Workforce is one of them and so there are difficulties in experimenting with alternative scenarios. Nevertheless the employees were more than willing to assist this research. It took several months to create the model and be able to draw reliable conclusions.

Simulation provided a low cost method that allowed us to gain a detailed understanding of the operations of the OEW and experiment with scenarios that can save cost and time. The main feature of this simulation model is the accurate depiction of all processes of the organization, based on some necessary simplifications, which did not reduce the validity of the model and the exported information. The deviations found in the model's results were not due to weaknesses of the model but to inadequate historical data.

Additional advances that could be performed in this system concern the creating of a historical database, so there would be more accurate data, and the extension to the inner procedures of the Organization.

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