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Simulation Techniques in Public Administration Procedures

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Sommario – 1. Introduction – 2. Influence of a Simulation Model on the Efficiency of Services in Public Administration. – 3. Quality in Administration – 4. The Bases of the Research – 5. Measurements – 6. The model – 7. Conclusion.

Abstract

Public administration is undergoing a series of reforms. These influence the management methods and techniques originating in the private sector in the management's everyday work.
With the intention to gain a more transparent overview of the administrative processes and to make them more transparent and manageable, the simulation methods are being implemented. They expose the weak points and bottlenecks of the organisation.
The article describes the problems of collecting the data on elementary operations. The documentation databases have been analysed with the aim to define the elapsed time for a single administrative operation and the probability of transformation of a transaction from one process state to another. The article presents the experience gained in the implementation of the Micrografx iGrafx Process 2000 as a simulation tool. It also provides a practical example of simulation of an administrative process by means of the above-mentioned tool.

1. Introduction

Providers of public services should provide the users with some of the essential information regarding the processing of their matters, such as the time required to solve their case, possible complications, additional obligations, and the current state of the application. This, however, requires a new definition of public procedures, a new organisation, and a corresponding information technology. These are the problems that are currently not controlled by the state and its institutions. There have been some improvements in the phase of activities' analysis, but there have practically been no solutions to the problems regarding the prediction of the time required for a certain application. Due to the nature of the problem, it is indeed very hard to make any prediction about the duration of a public procedure. Moreover, this involves a high level of risk.

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Hence, this problem demands a special methodology, which will allow simulations of various situations and methods of their solving. The solving of problems, which arise during the provision of services to citizens, has to aim at finding the optimum solutions. The services have to be provided optimally both as far as citizens' needs are concerned, taking into account all applicable norms, as well as far as the provider's financial and economic possibilities are concerned.

In practice, optimisation problems are often solved with simulation methods, although, regarding the nature of the problems, it would be more reasonable to use more exact methods of operational research. With the development of information and communication technology, this method of solving optimization problems is becoming increasingly popular. Simulations have proven to be more useful with problems, where methods of operational research would demand development of too complicated software or, in some cases, also hardware. There are several advantages of simulations in comparison to the exact mathematical modelling: "Most mathematical and statistical models are static. They represent a system at a fixed point in time. The passage of time is usually not a critical issue" [BANK98], and similarly Pidd: "Most mathematical models cannot satisfactorily cope with dynamic or transient effects" [PIDD98].

There are several reasons to use the simulation models:

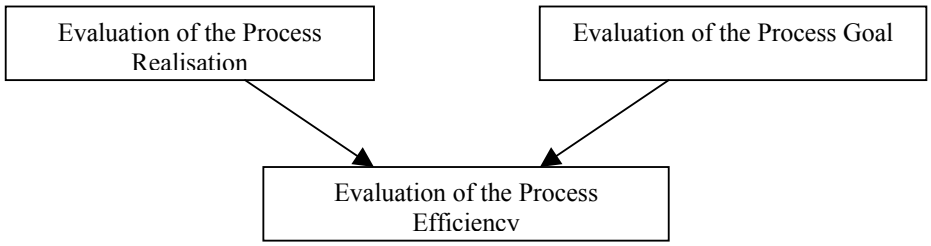
- Recognition of conditions of the process execution;
- Experimentation on the model before introducing the modifications into reality. This means a study of alternative solutions, possibilities for the optimization of the system's functioning or the process implementation – "choose correctly"[BANK98];
- Forecasts of process development and changes of conditions during its execution,
- Analyses of process realisations, the differences in comparison to the plan and the factors causing process's modifications.
- Execution of other management and controlling functions in the area of management of the process and its development.

In the public sector, there are many processes that could be dealt with simulation models. They involve particularly those, which are executed by the state or local self-government bodies for citizens. Mathematical models, written by complicated equations, would be too demanding and too hard for an ordinary citizen to understand. Due to the nature of the problem, e.g. returning to the previous state, repeating of the activities, simulations are the only way of fulfilling information demands in the management. That is why simulation techniques are becoming increasingly popular as a decision tool in everyday management.

2. Influence of a Simulation Model on the Efficiency of Services in Public Administration.

The efficiency of the public sector service can be established if we can determine the method of assessing the level of achievement of the service performance goal. This means that the process efficiency can be established if we can define the goal in a form, which would allow, along with the process realisation, evaluation of the goal achievement.

Scheme 1 – Evaluation of efficiency as a function of evaluation of process goals and process realisation



In the scheme 1: Evaluation of efficiency as a function of evaluation of process goals and process realisation, we illustrate the fact that the evaluation of efficiency (as an activity or a task) is equally conditioned by the evaluation of the goals and the evaluation of the process realisation. If any of these two is missing, the process efficiency cannot be evaluated. The efficiency evaluation is realizable if both activities of evaluation of results are carried out. It is also necessary to take into account that every such assessment is a result of comparative analyses (of goals and realisation), which means that the efficiency evaluation is realisable when provided with comparable data bases of evaluated goals and realisation. It is clear from the above-stated that an incomplete (or different) structure of goal or realisation evaluation prevents the evaluation of process efficiency. The analysis of process efficiency can thus be carried out with the application of:

- the methods of prediction of process goals,
- the methods of result analyses, and
- the methods of comparative analyses.

A simulation model is a method, which allows the prediction of process goals, along with taking into account the parameters of the results of completed processes or the assessments of the predictions of process parameters. According to its concept, the simulation method derives from the process realisations, which increases the applicability of the method from the point of view of exactness of the process efficiency evaluation.

Simulations can be defined as procedures of determination of a model, a computer programme, and experimental implementation of the studied processes. The subject of the study may be a process or a system. The suitability (quality, applicability) of a simulation model is verified by comparison of the real data with the data obtained by a simulation model. The more these data are similar, the better the simulation model is.

As can be seen from the above-stated, the development of a simulation model for the studied process comprises:

- a good analysis and knowledge of typical characteristics of system operation and procedures of process implementation,
- a development of an appropriate computer simulation model of the studied system and its processes,
- a test of suitability of a simulation model and an interpretation of the results obtained.

In the following part, we will limit ourselves to the identification of the applicability of simulation models in the management of public administration services, in particular to the processing of administrative matters. These services include issuing or changing of: building permits, identity papers, firearm certificates, etc. The procedures related to some of these may take a few minutes (identity cards), while with others they may take a few months or even years. Therefore, the measurement of efficiency of these procedures can be very complicated, and for the persons involved (citizens or officials) also very upsetting. Therefore, the introduction of the tools for the development of a suitable management of procedures could considerably contribute to the efficiency of their performance.

Prior to and during the performance of an administrative procedure, a simulation model allows us to perform a number of activities, which will facilitate the decision-making in the management, e.g.:

- contents definition – (sub)procedures to be included in the procedure,
- expected duration of the entire administrative procedure and completion of the (sub)procedures,
- the longest possible duration and the earliest completion of the administrative procedure,
- upon the completion of an individual (sub)procedure, the prediction of further (sub)procedures with assessments of their duration, completion and accompanying risks,
- prediction and monitoring of the costs related to the procedure,

- prediction of occupation of capacities.

The areas of use of simulation models of administrative procedures are presented in tabular form. By means of the table: The use of simulation models in the management process of administrative procedures in the light of the elements (factors) of a service process, we present the questions, to which useful answers can be provided by means of simulation models. The table shows that the areas, which are often declaratively mentioned by the new public management, are realizable with the introduction of simulation models into the management of administrative procedures. In relation to this, it is especially important to emphasise the following aspects:

- information of users on the duration of procedures and possible complications,
- recording the qualifications of officials to conduct the procedures and the ability to predict the procedures in terms of contents and schedules
- assessment of the suitability of equipment and manning,
- information of the persons responsible on the clerical malevolence and possible irregularities in the procedures,
- economic evaluation of the procedures and development of the system of indicators.

The development of the above-mentioned areas allows the development of the management, while at the same time the introduction of the mentioned activities promotes the development of the controlling function in the process of the state administration, since:

- the planning and directing of the procedures allow coordination among the procedures within their framework,
- it allows the analyses of efficiency and the prediction of the development of phenomena, and
- it allows the process information support, which is of key importance to the process management.

Table 1: The use of simulation models in the management process of administrative procedures in the light of the elements (factors) of a service process

	Factors of a service process				
Functions	**Capacities**	**Providers**	**Activities - procedures**	**Costs**	**Users**
Planning	Calculation of the necessary equipment, occupation of capacities	**Internal:** Planning of jobs, recruitment, encumbrance Suppliers and co-providers: in terms of schedules, quantity	Planned procedures and duration of activities, risks with procedures	Definition of budgetary needs, definition of standard costs	Duration of procedures, definition of a time schedule of an administrative matter
Management	Monitoring of occupation of capacities, bottlenecks and their removal	Encumbrance, removal of bottlenecks, monitoring of productivity, efficiency and quality according to positions and cost centres	Assessment of potential unsuitability of performed procedures (returns, complications), statutory obstacles, reality of time schedules	Monitoring of costs by cost centres, holders and types of services	**Information of the persons responsible** on the realisation of procedures **Information of the clients** on the state of the procedure
Analyses	Analysis of the use of capacities, assessment of reality of planning, deviations of the use of capacities from the planned one	Analysis of productivity, efficiency and quality	Suitability of procedures, simplification, complication, statutory obstacles	Analysis of deviations of the realised costs from the planned ones	Equality of users, detection of clerical malevolence

3. Quality in Administration

In the beginning, it was the 3E[1] principle which was pursued with regard to the public sector quality. Recently, the 3 Es were joined by a fourth one - equality or equity. This E requires that all citizens are at any time equally treated before an administrative body regardless of their sex, nationality, opinion, clothes, etc. This is laid down in the Constitution. However, the laws lay down only the guidelines and postulates of work, whereas the actual organisation of implementation is left to the management at the middle or lower levels. And the latter can be more or less efficient with their work.

The question is how to make the procedures uniform so that all citizens will be subject to equal treatment. How to find the right method of their performance?

4. The Bases of the Research

4.1 *The Method of the Research*

In our research, the answers were searched in a database containing documents of an administrative unit. Through the documentation, we observed the method of procedure performance. We limited ourselves to one classification mark and analysed the documents produced during the processing of a matter. Each document represented some event. “Events are classified into internal (endogenous) and external (exogenous)" [BANK99]. The internal events in a process are documents, which an administrative unit has drawn up, whereas external events are documents, which the unit has obtained. All cases started with an external event, i.e. filing of a citizen's application, and ended with an internal event, i.e. issuing of a decision. The procedure was completed with the finality of the decision, which, however, was not the point of our interest in the system.

An important datum is the date of the document generation. The analysis could be more thorough if we knew the time of document generation. Each document is produced in such a way that a case waits several days in a line of unsolved cases, but when its turn comes, the document is drawn up in a few minutes. Nevertheless, a rough date of the document generation will do in our research. A client - citizen is only interested in the time required to obtain the answer. The details about the time the document was waiting and the time the document was being produced are not relevant to him. These details matter to organisers and managers of administrative work.

With the recording of events represented by documents, we obtain a system of discrete states. From the point of view of the system, tow questions draw particular attention:

[1] Economy, Efficiency, Effectiveness.

- The time, which a matter spends in a certain state. This time can be obtained by deducting from the date of a generated document the time of the creation of a preceding document. This expresses the real time required for reaction to a document or for performance of an activity.

- The probability of transition into a new state. In certain places, certain states, there are two or several alternatives to proceed with a matter. The probability of transition into a certain state may demonstrate also too great enthusiasm, inflexibility or even malevolence of an official, who decides on the continuation of a matter.

Following the documents and thus defining the states allow us to identify the method of performance of a certain procedure.

4.2 *Software tool used and adopted*

"A system model plays a role of agreement between a user and a model designer. Therefore, it has to be presented in a way, which will be understood by both of them. This requirement excludes mathematical, mechanically oriented languages and supports diagrammatic visual languages, which can be understood intuitively"[Enge00]. Recently, the system modelling area has adopted the Unified Modelling Language. "For the modelling of data models it uses, among others, 'class' and 'object' diagrams. For the modelling of system behaviour, it foresees a number of diagram types, such as statechart, activity and sequence diagrams" [ELKO00], [BOOC98]. Each of these has a number of additional diagrams to clarify the process in more detail. Among them, we would like to mention the Control Flow and the Swimlanes diagrams [ERIC99]. The latter contain, in each section of a department or an organisational unit, symbols on the activities and alternatives.

In order to draw and to check the selected procedure by means of a model, we chose the software tool iGrafx Process 2000 of the company Mcrografx. With its rich library of symbols, which can be upgraded, the tool allows drawing of optional diagrams. For drawing of processes, it suggests the technique of a block diagram in a swimlane form with three basic symbols:

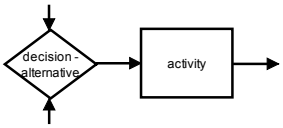
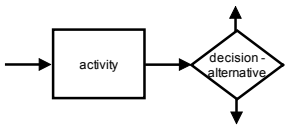
Table 2: Used symbols by Micrografx iGrafx Process 2000 program

	An oval to mark the beginning and the end of a procedure. This symbol is usually related to the transaction generator.
	A rectangle to sketch an activity. The activity is defined by its duration and the sources required for its performance.
	A diamond to mark an alternative in case of a decision. The alternative represents a point where one out of two or several ways is selected.
	Connecting lines – arrows show the course of the transaction flow. The arrows show the direction and the sequence of activities.

The activities and alternatives are drawn in lines, which belong to an organisational unit. The tool allows the definition of transaction generators and the simulation of model implementation. For an organisational unit, it keeps a record of (non)occupation, availability, costs, etc.

This gave us only the basic tool, which had to be adapted to a specific case, since it was not supported by any methodology. Therefore, we had to define the method of writing of transitions, as is known in Petri nets.

Table 3: Scheme of implementation of the Petri net transitions with the Micrografx iGrafx Process 2000 Tool

	The activity can be performed when both flows arrive. Example: the decision is issued if an opinion of a social service and a certificate of a tax authority have been submitted.
	The activity can be performed when the first of both flows arrives at the point of the alternative. Example: the investigation procedure is instituted following a charge or following a proposal by a prosecutor's office.
	The procedure performance follows one of the alternatives. Each alternative has a certain probability of being realised. Example: regarding the applicant, the opinion is requested from the police or a municipality. The analysis of events shows that 90 % of the matters continue with the investigation with the police.
	The performance of the procedure continues with both output flows. This involves a split of performance carried out parallelly, however, the branches may be joined afterwards. Example: a request to determine the location suitability of a building with regard to the water supply and electricity.

5. Measurements

5.1 The Observed Sample

We analysed 17 executions of the same process, i.e. 17 cases. The results of the measurements are presented in the table below. Case No: 1 was carried out in the following way:

1. In time 0, the permit application was received.
2. The administrative unit required a certain time to classify, sign and correctly deliver the application to a competent body within the composition. The head of the body

appointed an official, who within eight days upon the receipt of the application drew up a request for the opinion of the competent body.

3. The latter delivered the opinion after 26 days.

4. The document received was recorded in the case, delivered to the responsible official, and after 9 days upon the receipt of the answer from the competent body a decision was drawn up.

Results are listed in the table 4 below:

Table 4: Results for the observed sample of 17 matters

	Case																	
Appearance of the case with regard to the previous one:	*-*	*3*	*2*	*1*	*1*	*4*	*1*	*3*	*1*	*1*	*1*	*2*	*5*	*2*	*1*	*1*	*2*
State	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
1 Permit application submitted	8	9	9	8	10	7	8	9	5	8	7	8	9	9	7	8	8
2 Request to complete application							3									7	
3 Completed application received							9										
4 Invitation for an interview			5														
5 Request for opinion of an expert organisation			11				10										
6 Experts' opinion delivered			4				7										
7 Request for opinion of a competent body	26	23		30	22	24				23	24	23	28		23		22
8 Opinion delivered	9	9		7	8	9				11	8	9	7		9		11
9 Decision issued	8	8	8	8	8	8	8		8	8	8	8	8	8	8		8
10 Abandonment of the procedure								8								8	

On the basis of the measured data, we drew a model of the procedure. The table indicates:

- The average, minimum and maximum time required for performance of an individual activity,
- The probability of transition into a new state.

The results are shown in the following table.

5.2 *Calculation of activities*

Table 5: Probabilities of transformation from one process state to another

	Transition into a state												
State	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Avg*	*Min*	*Max*
1 Permit application submitted		0,12		0,06	0,06		0,46		0,24	0,06	8,06	5	10
2 Request to complete application			0,50							0,50	5,00	3	7
3 Completed application received					1,00						9,00	9	9
4 Invitation for an interview							1,00				5,00	5	5
5 Request for opinion of an expert organisation						1,00					10,50	10	11
6 Experts' opinion delivered							1,00				5,50	4	7
7 Request for opinion of a competent body								1,00			24,36	22	30
8 Opinion delivered									1,00		8,82	7	11
9 Decision issued									1				
10 Abandonment of the procedure										1			

Four organisational units can participate in the procedure: a citizen, an administrative unit, an expert organisation and a competent body in the composition of a competent ministry. Since our primary goal is establishment of administrative unit's efficiency, the last two organisational units can be joined into one unit, which will be called "external body". Individual units are responsible for performance of the following activities:

1. Citizen: (2) request to complete the application, (4) invitation for an interview;
2. Administrative unit: (1) permit application submitted, (3) completed application received, (6) experts' opinion delivered, (8) competent body's opinion delivered;
3. External bodies: (5) request for opinion of an expert organisation, and (7) request for opinion of a competent body.

The procedure always ends at the citizen, be it in a state (9) of an issued decision or (10) of an abandonment of the procedure.

6. The model

6.1 Input of Basic Data

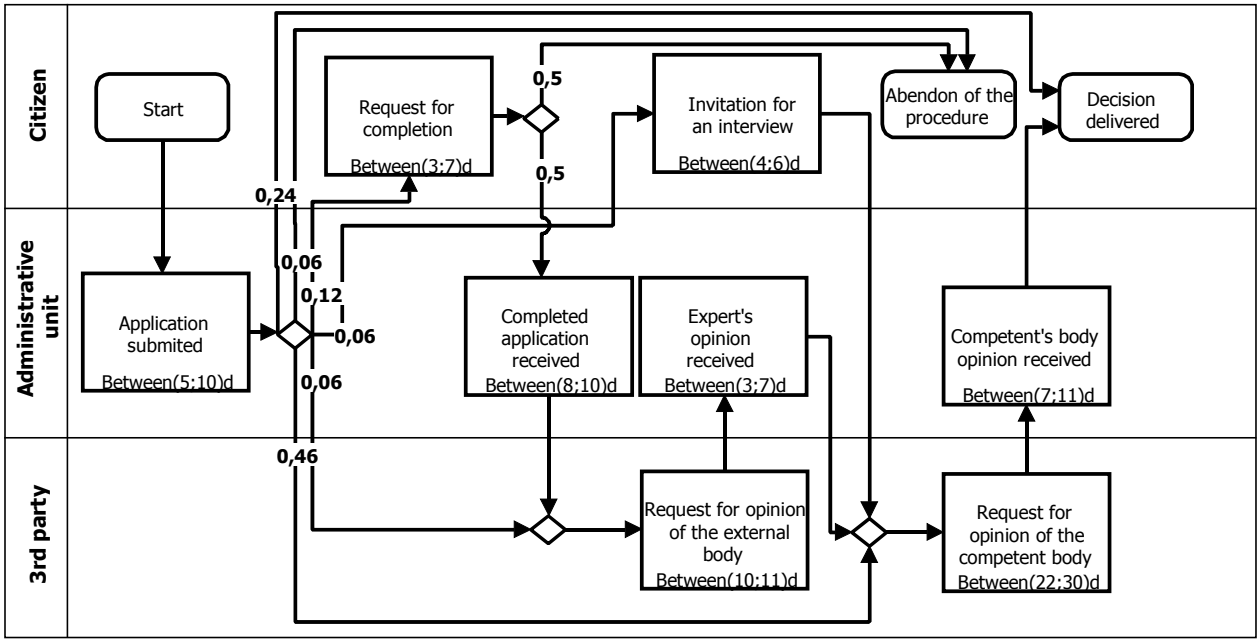
On the basis of the shown data, we designed a model of the observed procedure and draw it with the tool Micrografx iGrafx Process 2000. Each process in the graph has its name and duration marked. To determine the duration of the processes, we used the data from Table 5. The programme allows several ways of defining the duration of activities:

- Constant. The activity is always performed within the same time. The activities, which describe the services, "often depend on people who are inclined to greater unpredictability and variability" [LAUG98].
- Distribution. If the duration of the activity is not always the same, the programme allows the input of data in distribution. Distributions can be: normal - follows the laws of Gauss distribution; uniform - each result, between the lower and the upper limit of duration, has the same probability of generation; and
- optional - the user himself defines the formula of duration distribution.

In our model, all activity durations were defined as a uniform distribution. Due to a small repetition of individual activities, the duration of the activity "Invitation for an interview" was changed to an interval 4 to 6, and the "Completed application received" to an interval 8 to 10.

The model is presented in the scheme 2: Model of the administrative procedure, drawn with the Micrografx iGrafx Process 2000 tool.

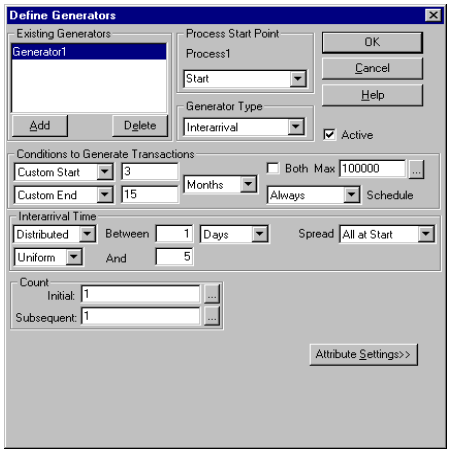
Scheme 2: Model of the administrative procedure, drawn with the Micrografx iGrafx Process 2000 tool. Below names of activities are stated durations.



6.2 *Input of data on the simulation*

To carry out a simulation, we have to prepare a simulation generator. The latter defines the time of entering of transactions into the system. "A transaction is actually a token, which travels within the system and which is subject to the activities" [PIDD98]. In our example, a transaction is an application, which is produced at the external event of filing of application. The final event is either the issuance of a decision or, in a few rare cases, the abandonment of the procedure.

Picture 1 – Definition of the generator



The observance of the application arrival dates in the system gives us the basic parameter of the generator - the frequency of transaction generation. First, we define the generator type. Since the system is activated at the arrival of a new application, we chose the generator type "interarrival". Another important data is the frequency of arrival of applications. According to the data, this ranges between 1 and 5 days. The distribution is, of course, uniform since we cannot expect people who file applications to subordinate themselves to some rules.

The programme uses a time schedule ladder related to a calendar. In relation to this, it considers that a day has 24 hours and a working day 8 hours. This can mislead the user who meets with the programme for the first time. The data just entered, i.e. the frequency of arrival of applications, mean that the applications arrive between 3 and 15 calendar days. Therefore, we defined the schedule of arrival as always (schedule= always).

The third vital datum is the simulation duration. We have to define the time of transaction generation. The time can be related to a certain date, however, in our simulation, we defined the simulation performance starts measuring after 3 months. This was done with the intention to simulate a real time situation. The process is continuously going on. Therefore the initial times of applications entering the system should not disturb the overall picture of performance. We decided to stop the simulation after one year (12 months) of recording. This means, that the period of generating transactions need to stop after 15 months.

Prior to the simulation, it is necessary to remove the definition of the sources required for the activity performance. The programme assumes that there is always one worker required for the performance of an activity. Therefore, it assigns one worker for each department or an

organisational unit. The arrival of the first transaction occupies the worker, therefore the other transactions wait in line since there is a lack of available sources. Since this is not the case in practice, all definitions of the required worker were removed.

6.3. *Results*

The results show that the processing of all transactions lasted about 70 weeks. During this time 136 transactions have been generated. This is the number of transactions that were processed from citizen and from the administrative unit. Some of the transactions have never reached the third party. It was involved only in 80 cases.

An average elapsed time to complete the transaction was 30 days. Administrative unit on average reacted on the event in 13,23 days. At the same time the third party – ministry and an expert body needed on average more than double time to complete their activities. This is a very important finding out, because it proves a more quality work at the administration unit comparing to the third party organisations. On the other hand customers – citizens cooperate only with the administrative unit. It can be said, that nearly any citizen is familiar with the administrative procedure that is going on. Therefore they blame for the delay administrative unit, even our research shows, that the major waste of time is coming out form the outside sources.

Data about the citizen is not realistic. Termination of the procedure counts as an activity. We did not find a possibility to exclude start and stop activities from the working counter. This is also the main complaint we have over the Micrografx iGrafx Process 2000 program.

Picture 2 – Output print list for the stated model

Elapsed Time - Weeks

70,37

Transaction Statistics - Days

#Trans	Avg Cycle	Avg Serv	Avg Work	Avg Res Wait	Avg Block	Avg Inact	Avg Wait	Avg Serv Wait
136	30,12	30,12	30,12	0,00	0,00	0,00	0,00	0,00

Transaction Statistics - Days

	#Trans	Avg Cycle	Avg Serv	Avg Work	Avg Res Wait	Avg Block	Avg Inact	Avg Wait	Avg Serv Wait
3rd party	80	27,22	27,22	27,22	0,00	0,00	0,00	0,00	0,00
Administrative unit	136	13,23	13,23	13,23	0,00	0,00	0,00	0,00	0,00
Citizen	136	0,88	0,88	0,88	0,00	0,00	0,00	0,00	0,00

Activity Statistics - Days

	Tot Cycle	#Trans	Avg Cycle	Avg Serv	Avg Work	Avg Res Wait	Av
3rd party - Request for opinion of the competent body	2073,34	80	25,92	25,92	25,92	0,00	
Administrative unit - Application submited	878,00	119	7,38	7,38	7,38	0,00	
Administrative unit - Competent's body opinion received	724,60	80	9,06	9,06	9,06	0,00	
3rd party - Request for opinion of the external body	103,99	10	10,40	10,40	10,40	0,00	
Citizen - Invitation for an interview	76,40	15	5,09	5,09	5,09	0,00	
Administrative unit - Expert's opinion received	47,38	10	4,74	4,74	4,74	0,00	
Citizen - Request for completion	30,66	7	4,38	4,38	4,38	0,00	
Administrative unit - Completed application received	26,82	3	8,94	8,94	8,94	0,00	
3rd party -	0,00	10	0,00	0,00	0,00	0,00	
Citizen - Start	0,00	119	0,00	0,00	0,00	0,00	
3rd party -	0,00	80	0,00	0,00	0,00	0,00	
Administrative unit -	0,00	119	0,00	0,00	0,00	0,00	
Citizen -	0,00	7	0,00	0,00	0,00	0,00	
Citizen - Abendon of the procedure	0,00	10	0,00	0,00	0,00	0,00	
Citizen - Decision delivered	0,00	108	0,00	0,00	0,00	0,00	

7. Conclusion

As suggested by the authors of simulations, such as Pidd [PIDD98], Banks [BANK98] etc., it is first necessary to check the obtained model and to establish its credibility. After the accuracy of the set model has been confirmed, the next phase can begin – the reengineering of processes, where with the redistribution of activities and sources we can achieve new, better and higher quality.

Our contribution allows especially:

- Making the same procedure uniform in all administrative units. This would assure equality of procedure performance regardless of the location of the application.

- Documenting the course of a certain procedure. With a simple technique, we can activate a broader community to enter a dialogue on possible improvements of an individual procedure. Until the procedures have not been drawn, the discussions are impossible. This has been confirmed also by the present-day practice.

- A concept for information support of automated procedures. As ascertained by some authors "the workflow technology, despite its eminence, does not achieve a larger share on the market of computer applications. The reason for this can be attributed to its rigidity and complicacy, therefore their planning requires an expert and cannot be left to the users themselves" [DEMI99]. By means of a simple software tool, such as iGrafx Process 2000, the users can themselves define the course of the process performance.

The essential advantage of the method lies in the fact that all data about the activities are acquired from the existing documentation database. This means that they are not intuitive. With a proper computer application support, the data can be obtained automatically, which is important from the point of view of the costs. And these practically do not exist.

The analysis of a larger number of administrative units can involve a comparable analysis. We can compare the time spent on performance of an individual activity in an administrative unit. With this, we gain the beginnings of benchmarking between individual administrative units.

Within the meaning of New Public Management, this is an important contribution to a new organisation of administration and a step closer to work control and supervision as known in the private sector.

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