

THE SIMULATION OF SOFTWARE PROCESSES IN THE INTEGRATED COMPUTER ENVIRONMENT IN THE CASE OF TELCO SECTOR

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Abstract. In the paper the examples of software process simulations in an integrated IT environment are described. All examples come from an integrated IT environment in one of the biggest Polish firms in TELCO sector. Simulation models description is based on BPMN standard and ARIS Business Simulator was used as a tool to conduct experiments. These models describe the process of introducing a new product/service to the integrated IT environment. Models can be used to mold the behavior of the environment in case of any changes to it, as well as to optimize parameters such as processes execution times, waiting times for the event initiating an instance of the process, resources and costs due the process.

Keywords: process simulation, process modeling, process optimization, cost optimization, EAI (Enterprise Application Integration), ARIS, BPMN, integrated IT environment.

1 Introduction

In contemporary times all the organizations, in the greater or lesser extent, support their business activity, by intensive usage of information technology. Progress in computerization has led to a situation that the number of information systems of all sizes, simultaneously used in companies, sometimes can be counted in the hundreds. Even companies that have invested considerable resources in an integrated MRP II /ERP systems, hoping that it will replace many other domain systems, are not in much better position. The need for rapid response to the continually emerging challenges of the market, forces a rapid (sometimes measured in weeks) implementation of new supporting systems or modification the old ones in such a way that they can handle the emerging demand for IT services. Of course, it rarely happens that numerous systems used in the organization were isolated island, working completely independently from other systems. In practice, information systems are integrated with others in some way, often through the use of middleware.

The above situation is general in nature. But the same is the case in the telecommunication companies, which are well recognized that intensively use the computers, and their activities are largely based on the use of information systems. The situation described later in the paper refers to the situation in the largest Polish telecommunication company – Telekomunikacja Polska JSC. (TP JSC). But that is only an exemplification of the issue, since the similar problems have all big companies that widely use IT.

In TP JSC there is a complex IT environment, which includes several key domains: CRM, Billing, ERP, DWH (DataWareHouse), Portal(s), OSS (Operations Support Systems) etc. One or more application systems (AS) operates in each of these domains. All these systems spans integration layer EAI (Enterprise Application Integration). EAI platform is a separate, specialized part of the IT infrastructure responsible for achieving integration between applications (systems) that support various activities in the enterprise [5]. In this way, EAI platform becomes an important element in the company's IT infrastructure: it enables sharing of data and key business processes among any connected application and therefore is a mission-critical part of infrastructure. This situation is illustrated in Figure 1 (Note: for simplicity, each domain consists of two applications).

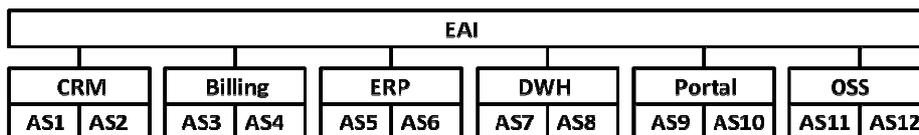


Figure 1. Relationship between the domains of TP JSC

If it's required by business considerations (e.g. the need to offer customers a new service or product, the organization of new promotions, etc.), it becomes necessary to adjust the environment so that it assists the

consultants, or directly to customers purchasing a service / product on-line (independently through the portal), by providing them with adequate functionality of the application system.

Operations performed to modify such an infrastructure and environment to create this functionality, constitute so-called system processes. An instance of a single system process is carried out within the software project. The result of the realization of many projects is carry out changes in the integrated IT environment, allowing firm to offer a new service or product for customers. Provide new product / service is usually associated with the need to make changes in various applications, comprising the majority of mentioned domains.

Typically, changes made in applications or in the integration layer, in order to obtain a new product, tend to be of two types: major changes, requiring modifications in the source code of applications, known as editions and minor changes, which involve changes in the configuration of some systems (applications). A sequence of such changes, related to the realization of individual projects can be presented in the matrix form (Table 1).

Table 1. Projects P_i lead to changes in several domains D_j

Domain Project	D_1	D_2	D_{m-1}	D_m
P_1		X			X
P_2	X	X	X	X	
...			X		
P_{n-1}				X	
P_n				X	

The individual rows of the Table 1 should be interpreted as completion of subsequent software projects involving changes in the system processes or introducing new processes in different domains. Thus, the project P_1 requires changes in applications from the domains D_2 and D_m ; the project P_2 - in domains D_1, D_2, \dots, D_{m-1} .

When planning implementation or modification of various software processes in an integrated environment to provide a new product or service (e.g. to provide broadband Internet access via telephone lines), the following aspects should be considered:

- system processes are decomposed to the elementary processes, and each of them can be activated many times (e.g. conducting multiple configurations) - in other words, each process considered as a class can have multiple instances; in order to execute the process, necessary resources should be allocated (people with specific skills who may not be available due to their involvement in another process instance),
- execution of each instance of the process requires some time (depends on the number of employees and their involvement),
- costs of the execution of process instance,
- frequency of the occurrence of instance in a certain period of time (e.g. number of configurations of the application AS in the period between editions),
- probability of the process instance in the period under consideration,
- the average waiting time for the launch of the next instance of the process simulation model.

What's more, there is usually a strictly defined order in which every elementary process must be executed (for example, analytical activity should be completed prior to design activity). Single system process optimization may be inefficient, because there may be a dependence of this process from other system processes. For example, this may include the need for early implementation of a particular product or due to the scarcity of human resources.

Therefore, when management tries to optimize the portfolio of ongoing software projects, dividing each of them to the elementary processes and manually making the allocation of resources (mainly staff), the resulting effect may be imperfect – some employees have to wait to the others who have not finished their work yet. The solution, which can be applied in this situation, is to simulate this system process earlier in the context of the constraints posed by other, parallel simulated system processes.

This paper aims to show the possibilities offered by the simulation of system processes performed in the integrated environments of telecommunications company. A simulation allowing to make changes in the

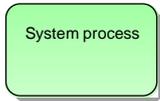
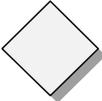
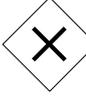
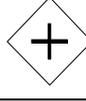
parameters of system processes, not only enabled the modeling of the environment, but also to optimize the process. The simulation results described in the paper allow to the optimize the system in terms of business parameters such as:

- preparation time and duration of processes (e.g. preparation and performance of the configuration),
- analysis and cost optimization of processes,
- loading level of the organizational units (ranging from development centers),
- answers to the questions like: "What-if", for example: "How will it affect the distribution of costs between the processes, if we increase the proportion of configuration projects compared to the editing project by 10%?".

2 Notation for the simulation models and symbols used

System process model, which will be described later in this paper is presented in standard notation BPMN*, using the ARIS** (ARIS Business Architect 7.1). Description of meaning of the symbols has been included in Table 2.

Table 2. The meaning of symbols used in BPMN notation to describe the process simulation models.

Abbreviation / term	Description
	Graphic symbol of the system process
	Symbol of the decision function
	Symbol of the initial event
	Symbol of the intermediate event
	Symbol of the final event
	Symbol of the „XOR” operator
	Symbol of the „OR” operator
	Symbol of the „AND” operator
	Transmission Control (indicating the connection between processes and order of the processes)

* BPMN [1] - graphical notation based on graph theory [2] used to describe business processes [6], promoted by the Business Process Management Initiative; practically it's a standard of that description and is consistent with the concept of SOA. Notation based solely on BPMN is insufficient to carry out the simulation, because in BPMN can't hook up to the processes the organizational units responsible for each process. Therefore, the notation is supplemented by "Functions allocation diagrams" hooked to the processes.

** ARIS – Architecture of Integrated Information Systems – architecture methodology and tools developed by IDS Scheer ([9], [10]).

3 Model of the simulated process

Table 3 lists the signs of individual components and applications that will be used later in the text. Figure 2 shows a main BPMN process model to provide a new product. The object of the simulation described in the next section was a model shown in Figure 3, which constitutes a development process no. 02 (Configuration and development of ZS GTP components) from Figure 2.

Table 3. Relevance to the components / applications of the simulation model

ZS GTP	Integrated IT Environment of the TP JSC
UAT tests	End-user acceptance tests
Go-Live	Production stage of the system.
EAI	Separate, specialized part of the IT infrastructure, responsible for integration between applications (systems) that support various areas of activity.
KP PS CRM	PeopleSoft's CRM system running in TP JSC
CA KSP	National Inventory System - an application of TP JSC. The module enables recording of logical and physical resources of telecommunication and data communications networks and the services running on these resources.
SERAT	Billing system operating in TP JSC.
OM	Order Management - orders management system.
FT (Fast TRACK)	The project, whose results are limited to the configuration of parameters of the integrated IT environment in TP JSC.
DPD	TP JSC application for outsourced service delivery by the courier company DPD
OFK	Courier service module - generate orders for courier company.
OPTIPOS	The main sale system of TP JSC services.

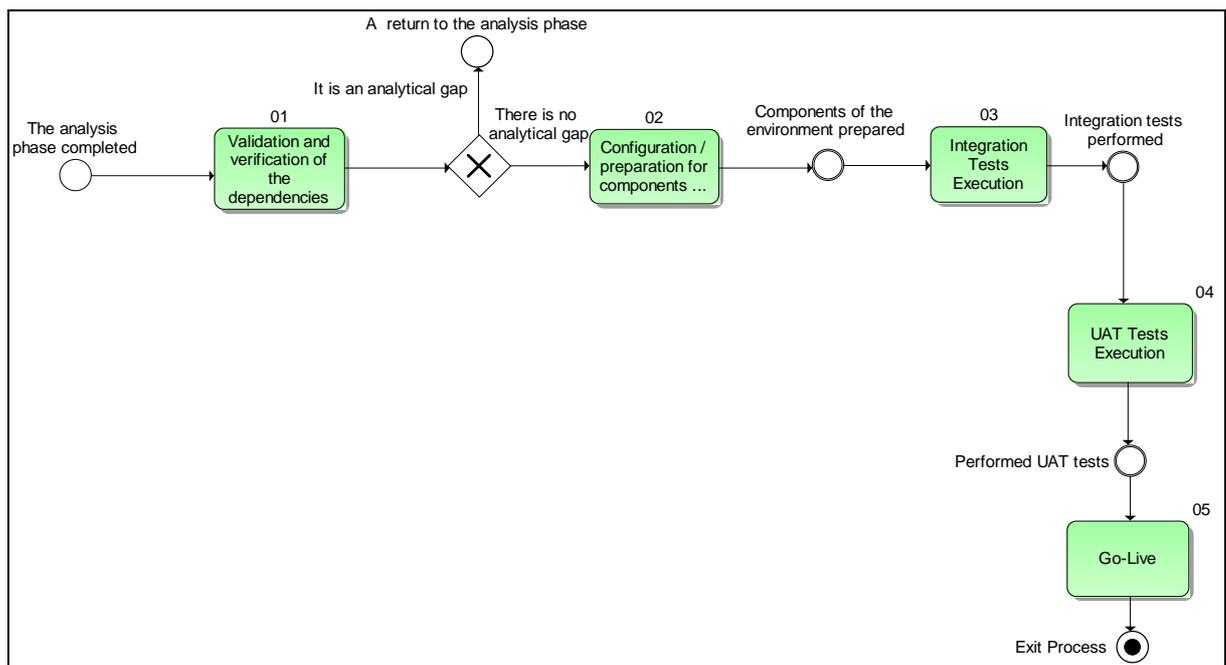


Figure 2. Main BPMN model of the process of product delivery. Source: author's research.

Figure 2 shows the main process model for IT project conducted in an integrated IT environment. It is a typical waterfall process with possible iterations. The subject of future simulation is subprocess model no. 02 (Preparation and configuration of integrated environmental components (ZS GTP)), whose structure is presented in Figure 3 in the form of BPMN model. This model can be considered as a reference model for the described IT environment [8].

Every process is surrounded by numbers, presenting simulation results, as described on Figure 4:

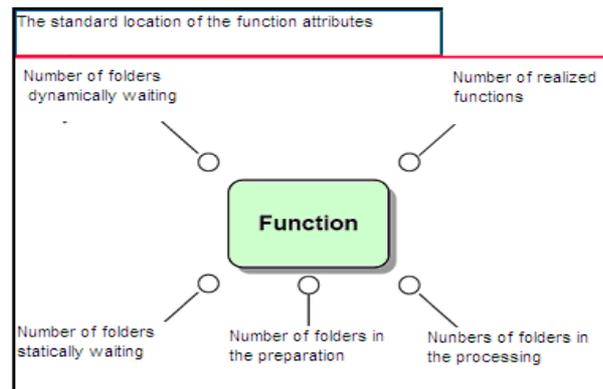


Figure 4. The meaning of the individual numbers, describing simulation progress

The meaning of the various descriptions in Figure 4 is as follows:

- number of folders dynamically waiting – number of instances of processes, waiting for execution due of human resource absence (e.g. in the same time, needed resources are busy because of handling other processes),
- number of realized functions – number of instances, each has been carried out and completed,
- number of folders statically waiting – number of instances of processes that can not be done; they are not waiting for resources, but for trigger from decision point XOR or parallel AND flow,
- number of folders in the preparation – number of instances of the process, which are in preparation status (some processes require preparation time to run them),
- number of folders in the processing – number of instances of processes, which are currently in processing status.

The process shown in Figure 3 begins with the initial event "Information about the change received" meaning to launch a new project in conjunction with entering change request. The change concerns the introduction of new telecommunication product / service or modify them. During the simulation 154 such events were introduced based on the average number of new projects during the half year. Each new event is generated randomly and starts the simulation of the whole model. Then new instances of individual processes are generated in the model, until the entire set of the 154 events is completed. Depending on the type of changes resulting from the type of project, generated event redirects the simulation (using "XOR" operator) on one of three branches corresponding to either the project: "Change of FT without new templates" or "New product or bundle" or "New promotion with a new template". Redirection for each event can occur with a probability corresponding to the frequency of the type of project in the overall portfolio of projects (events). Output from the model corresponds to the full preparation of an integrated applications environment.

4 Selected results and analysis obtained during the simulation

Here are some types of analysis that can be obtained by the simulation. **Input parameters** treated as the process requirements [7] for detailed processes of the model in Figure 3:

- number of events involving the launching of a new IT project in the period of time 'X',
- probability distribution of the input stream of events by the operators "XOR"
- duration of the process (or the statistical distribution of the time - chosen from a list of available types of distributions),
- preparation time for each process on model (or the statistical distribution of the time - chosen from a list of available types of distributions),
- process costs (maximum and minimum – or different types of statistical distribution costs - chosen from a list of available types of distributions),
- volume of human resources to complete the process (number of persons and the extent of their use) and the order in which they start.

Output parameters:

- total downtime (or expected downtime) by the different types of projects, phases of the process - this allows to optimize the schedule and resources,

- the total annual duration of the processes (or the estimated duration of the process), according to different types of processes,
- utilization rate (real or expected) of the resources of the organizational units or the teams used to perform processes,
- effectiveness of use (or predicted effectiveness of the use) of resources (total downtime comparing to all available time),
- the total annual cost (or estimated annual total costs) of processes of a particular type.

Statistical analysis of simulation results were conducted using a standard module ARIS Business Simulator. Statistical analysis can help you find the bottlenecks and resource utilization in the simulation model. Their credibility is related to the degree to which a simulation model reflects the actual course of the process. The simulation model should be a subject of iterative improvement as a result of the statistics obtained from the simulation to reflect the actual course of processes. Improvement of this model is done by manual tuning involving the modification of input data to the process, or in extreme cases, the changes to the model.

Figure 5 shows the form corresponding to a model of the single process in Figure 3, where input data are entered and where results of simulations are displayed.

Attributes	
Attribute name	Untitled (Polish)
Type	Function
Time of generation	2009-03-30 15:58:06
Creator	system
Last change	2009-03-22 01:00:04
Last user	system
Frequency, annually	
Avg. total costs	25 000 PLZ
Min. total costs	24 800 PLZ
Max. total costs	25 200 PLZ
Static wait time	
Orientation time	(0004:00:00:00) Constant
Processing time	(0020:00:00:00) Constant
Process folders processed	107
Static wait time sum	0000:00:00:00
Dynamic wait time sum	0627:18:49:25
Orientation time sum	0448:00:00:00

Figure 5. Sample data entered into the process "Configuration of KP PS CRM" (costs, time of preparation, processing time of the process) and data calculated during the simulation (total waiting time, total time of preparation).

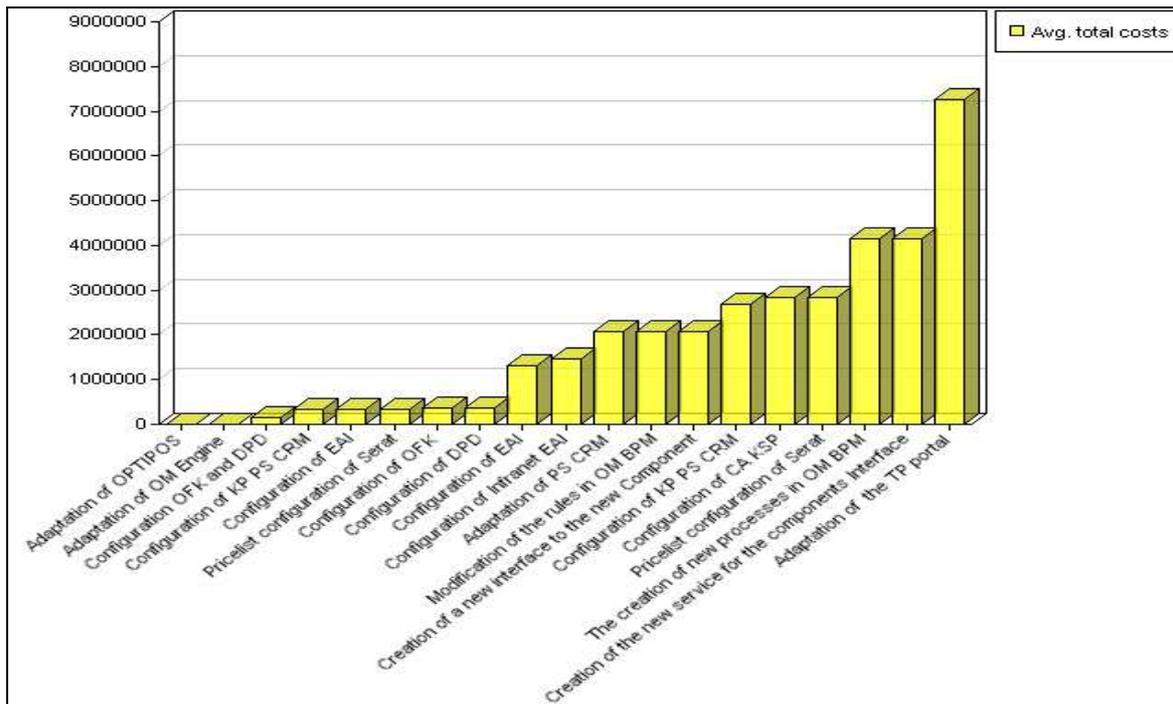


Figure 6. Total annual cost of the processes of a different type (vertical axis in the PLN).

Cost optimization of the process shown in Figure 6 requires the selection of the durations of such processes and the allocation of resources to conduct the process to keep the cost of each process within a specified range with minimal total cost for the whole model. This requires multiple iterations of simulation with different initial data sets for each process.

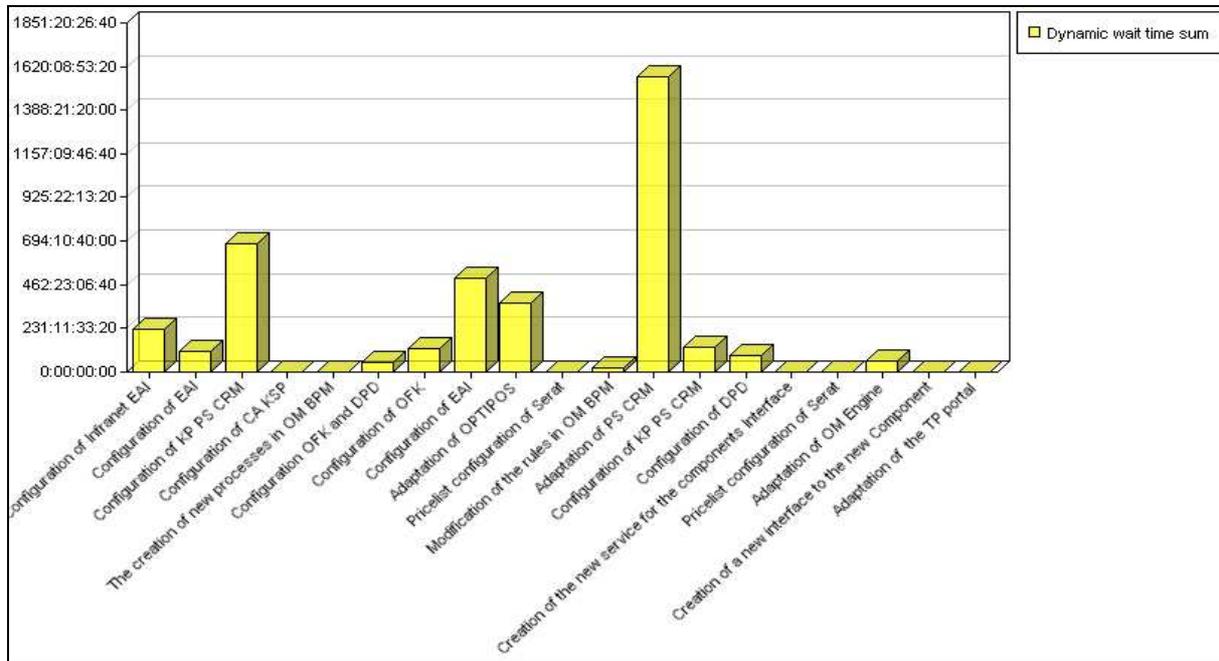


Figure 7. Total downtime (a process waits for completion of another process) - the vertical axis shows the time – days: hours: minutes: seconds. Source: author's research.

Total downtime of individual processes is shown in Figure 7. It allows to identify so-called "bottlenecks" in the model associated with the time of realization. The figure shows two such "bottlenecks" related to the process realization: "Adaptation of PS CRM" and "Configuration of KP PS CRM". Removing these bottlenecks is done either by shortening the process preceding the waiting process without increasing resources for projects, either by increasing the resources that support the process before.

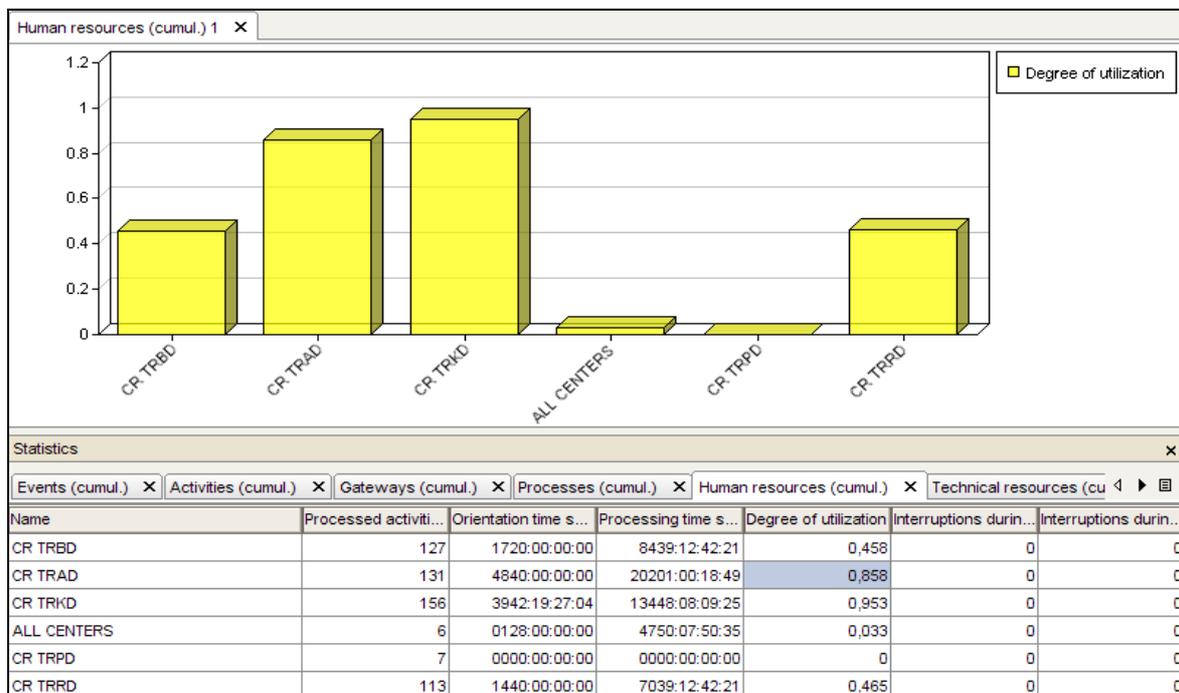


Figure 8. Utilization rate of resources used to implement the processes by organizational units. Source: authors.

Only once before this work, in TP JSC had been carried out simulation experiment on a model of integrated computer environment ZS GTP but on the another business area [3]. Therefore, the results from the model optimization could be compared only with real results for previous editions of this environment, calculated in the traditional way (the real durations of individual projects and their real costs). This comparison shows the broad consistence of the results obtained in simulation with the real results for each class of projects in this edition.

This means nothing less than a high compatibility of the proposed simulation model shown in the Figures 2 and 3 with the real implementation processes in the present edition. Confirmation of the correctness of the model against actual processes allows to conclude accuracy of this simulation technique.

5 Conclusion

System processes simulation in the integrated environment TP JSC allows to find a correlation between the parameters of these processes and then optimize those processes, according to the global parameters such as waiting times, process execution time, the cost of processes, executing processes, use of resources. Such a simulation should be conducted under conditions anticipated changes in the integrated environment implied by the introduction of new products or services. These changes are actually carried out either by projects such as "fast track" projects, where the now code is not written and new editions projects (related to the development or modification of the code). Due to the high complexity of the IT environment in the TP JSC Group is not possible to predict the "ad hoc" results of these changes. Therefore, it is desirable to build simulation models and their optimization in order to better prediction effect of changes in the integrated environment. Simulation models brought correct results for historical data (from previous editions), which indicates their relative accuracy and the possibility of future prediction the new editions of the IT environment in the TP JSC Group.

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