

Simulation Studies in a Low-Code Development Platform for Improving the Flow of Internal Electronic Documents

Tadeusz Nowicki¹, Robert Waszkowski¹,
and Agata Chodowska-Wasilewska²

¹Cybernetics Faculty, Military University of Technology, 00–908 Warsaw, Poland

²Tecna Sp. Z o. o., 01–496 Warsaw, Poland

ABSTRACT

This paper shows how to model and simulate the business process the flow of internal electronic documents in the organization. The constructed process and its equivalent in the Low-code environment allow for the simulation of the functioning of internal electronic documents flow process and obtaining results for various values adopted in the characteristics model. This gives the opportunity to examine the properties of the internal electronic documents flow process, find bottlenecks, lack of appropriate resources, etc.

Keywords: Electronic document flow, Business processes, Simulation, Business process property investigation

INTRODUCTION

The article shows a methodology for investigation the properties of real processes described by business processes (Dirk et al., 2009), (Jasiulewicz-Kaczmarek et al., (2018) and (Wang et al., 2005). Studying the properties of a business process allows you to evaluate various properties of a real process. The study of the business process takes place in a Low-code platform (Waszkowski et al., 2019), (Waszkowski et al., 2021), (Waszkowski, 2022). This gives the opportunity to study the properties of processes even for people who do not know the methods and technologies of programming, in particular the design and implementation of computer simulators (Jonkers et al., 1996), (Kiedrowicz et al., 2016), (Waszkowski et al., 2012) and (Waszkowski et al., 2018). Low-code platforms also help in modeling and optimizing the effectiveness of various types of administrative and warehouse processes (Kiedrowicz et al., 2017a), (Kiedrowicz et al., 2017b), Waszkowski et al., 2020). AI methods are sometimes used for these problems (Mrugalski et al., 2003) and (Mrugalski et al., 2007).

Using low-code development platform we can offer several significant benefits for manufacturing processes. In Low-code system, the Forms module is responsible for user data processing. All the data and their subsequent versions are stored in the database. It helps to organize the knowledge transfer from one part of the organization to another (Waszkowski et al.,

2017), (Dudek et al., 2016), (Patalas-Maliszewska et al., 2015), (Patalas-Maliszewska et al., 2020), (Pazera et al., 2020) and (Witczak et al., 2020).

In this case, the process that is related to the flow of internal electronic documents in the organization is considered. The process begins when there is a need to prepare an internal electronic document in organization. The flow of electronic internal documents can be initiated by various persons. The new document can be information for staff, decision, or announcement. Electronic internal documents during the flow can be modified, submitted for approval, completed, saved in the knowledge base, cancelled etc. The process ends by saving the document to the knowledge base. The number of internal electronic documents sent during the day is usually very large. Therefore, it is worth to consider improving the flow of internal documents in the organization. Supporting the process of electronic internal documents flow will make it easier for employees to prepare, distribute, modify, accept and, as a result, save such documents in the knowledge base.

A process of internal electronic documents flow is constructed. Its equivalent in the Low-code platform is also presented. This platform has built-in simulator. Simulation experiments allow to analyze various dynamic properties of real processes described by business processes. Business processes and its elements can be described by many various characteristics such as: random streams of internal document generation, execution times of detailed tasks, probabilities of certain events controlling the flow of documents, costs of tasks, work schedules of individual employees, parameters of shared resources, organizational structure, etc.

Simulation of internal electronic documents flow in Low-code platform allows to obtain results for various values of characteristics defined in the model. This gives the opportunity to examine the characteristics of the internal electronic document flow process itself, find bottlenecks, lack of appropriate resources, etc. Such an analysis is very important from the point of view of the human factor in relation to the employees of the organization.

As a result of a series of simulation experiments, several interesting characteristics related to the internal electronic documents flow can be obtained. Interesting statistics are shown related to the execution times of various types of actions, their execution costs, waiting times for various steps of the document flow. For employees participating in the electronic internal documents flow, their time load on individual tasks in this area can be determined. It is possible to show (indicate) those actions that are activated most often or those that are activated rarely. The degree of resources use in the process of electronic internal documents flow may also be interesting. A few characteristics can be displayed in tabular or graph form easy to analyze and evaluate.

CHARACTERISTICS OF INTERNAL ELECTRONIC DOCUMENT FLOW PROCESS

The process begins when there is a need to prepare an internal document in the system. The new document may be a document, which may be an order decision or announcement. The process ends by saving the document to the knowledge base. The employee can start the internal document circulation

process. He has the option to create a document on his own initiative or upon the request of the Director. In the case of creating a document at the request of the Director, after completing the creation of the document, it is sent for approval by the Museum Director. After creating the document on his own initiative, he sends it for approval by the Head of the Department. He is responsible for making corrections to the document. The director may start the internal document circulation process. He can create, sign and approve the document himself, and then add it to the knowledge base. It can also start the document circulation process and commission the employee to create the document. After creating the document by the Employee, he is responsible for accepting the document. It has the option of accepting, rejecting, or directing the document for correction. After accepting the document, he signs it electronically. Only his signature on the document makes the letter valid. The Deputy Director is responsible for verifying the document created by the Employee after prior approval by the Manager. They can accept the document and refer it to the Museum Director for approval, reject it or refer it to an Employee for correction. The Department Manager is responsible for verifying the correctness of the document created by the Employee. If he accepts the document, he passes it on to the Deputy, Deputy Museum Directors or the Museum Director for approval. He has the option of rejecting the document or referring it to be corrected by the Employee. Persons designated by the Employee Persons designated by the employee creating the document have the ability to edit the created document and the obligation to approve the data if they do not introduce changes. In the registers, everyone can see internal documents created by the relevant employees.

In Fig. 1. a business process constructed for the case of internal electronic documents flow in an organization was shown.

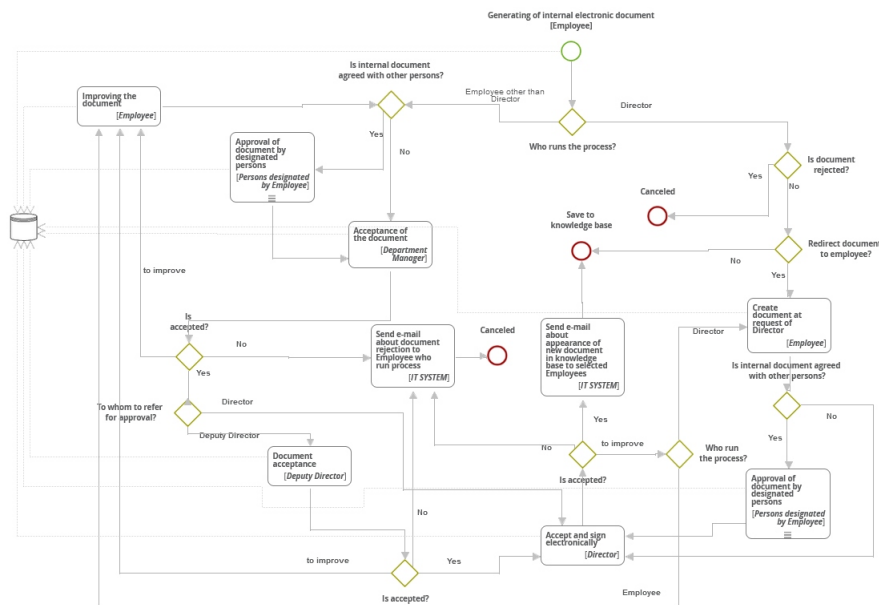


Figure 1: Business process of internal electronic documents flow (source: own study).

IMPLEMENTATION OF A BUSINESS PROCESS IN THE LOW-CODE ENVIRONMENT

To simulate the business process relating to internal electronic documents flow, this process can be implemented in the iGrafx environment, which is a low-code type system. This process made in iGrafx environment is shown in Fig. 2.

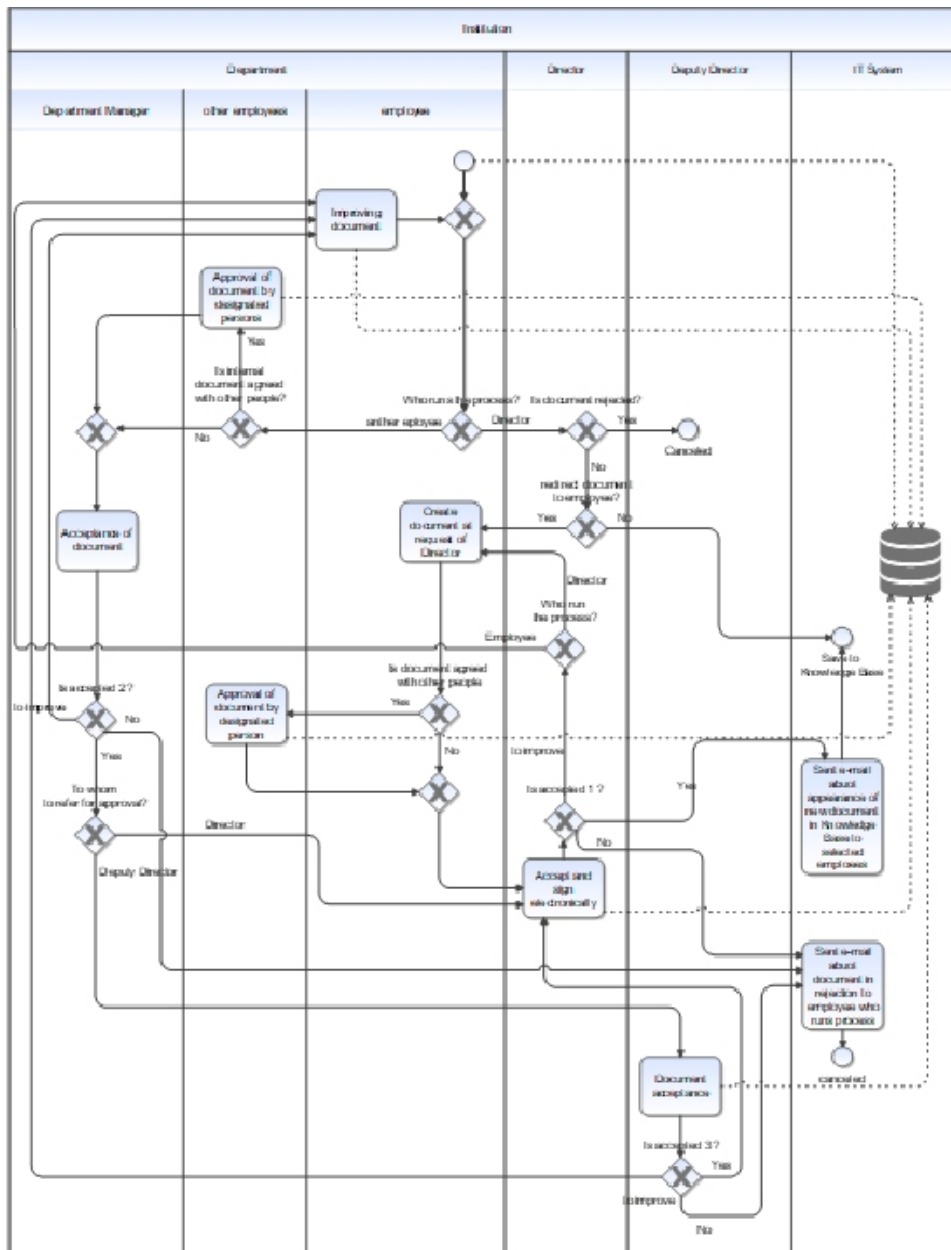


Figure 2: Business process of internal electronic documents flow in Low-code platform (source: own study).

For the process implemented in the iGrafx environment, a few data necessary to run a computer simulation of the process functioning must be declared. The structure of a part of the organization corresponding to internal electronic documents flow in the organization was established. This structure is shown in Fig. 3.

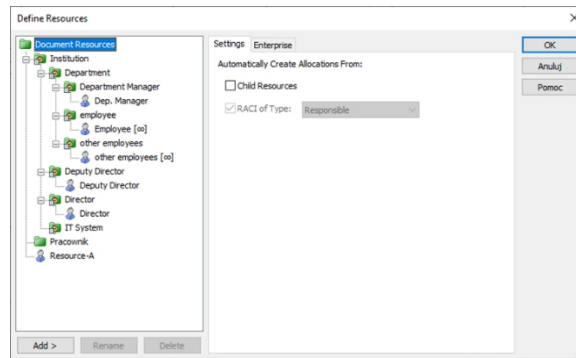


Figure 3: The structure and resources of business process related to internal electronic documents flow in iGrafx platform (source: own study).

For all tasks (activities) in business process we can define their random performance characteristics: time and cost (Fig. 4).

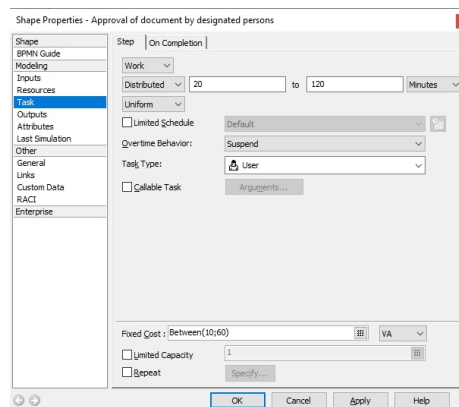


Figure 4: Random performance characteristics for business process of internal electronic documents flow in iGrafx platform (source: own study).

Each of the people shown in the organization structure has a fixed work schedule. We can determine the hourly scope of work of people participating in the process of documentation circulation in the organization by planning their actual working hours, lunch breaks, other breaks, etc. The method of planning the work schedule is shown in Fig. 5.

It is necessary to specify the flow of electronic documents. The characteristics of internal electronic documents flow must be determined. The

parameters of internal electronic documents flow generator are shown in Fig. 6.

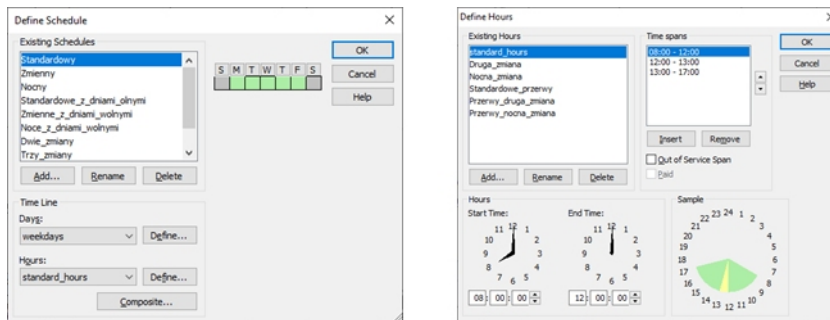


Figure 5: Time schedule for employees in business process related to internal electronic documents flow in iGrafx platform (source: own study).

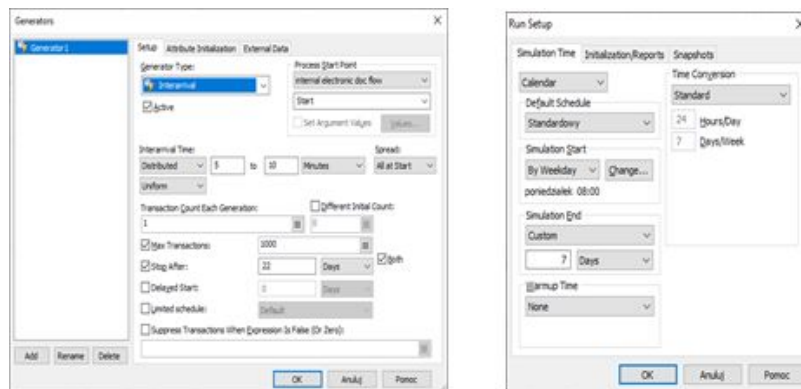


Figure 6: Characteristics of internal electronic documents flow in iGrafx platform (source: own study).

RESULTS OF SIMULATION EXPERIMENTS

As a result of the simulation experiments, several interesting combinations related to the process of internal electronic documents flow were obtained. You can show statistics relating to the execution times of various types of activities (Tab. 1).

Similarly, statistical collective characteristics relating to various activities are recorded (Tab. 2).

It is also important to show the characteristics related to individual resources in the model. Several properties of the processes of using these resources in the process of electronic circulation of documents can be shown (Tab. 3).

This type of characteristics can also be shown in the form of various types of pie (Fig. 7).

Table 1. Statistics relating to the execution times of various types of activities in the iGrafx environment (source: own study).

Transaction Statistics (Hours)								
	Count	Avg Cycle	Avg Work	Avg Wait	Avg Res Wait	Avg Block	Avg Inact	Avg Serv
Institution/Department/Department Manager	180	25,96	0,27	25,69	9,14	0	16,55	9,41
Institution/Department/employee	547	0,41	0,14	0,27	0	0	0,27	0,14
Institution/Department/other employees	197	4,31	0,94	3,37	0	0	3,37	0,94
Institution/Deputy Director	273	0,13	0,06	0,06	<0,01	0	0,06	0,06
Institution/Director	449	3,25	0,16	3,08	1	0	2,08	1,17
Institution/IT System	336	0,02	<0,01	0,01	<0,01	0	0,01	<0,01

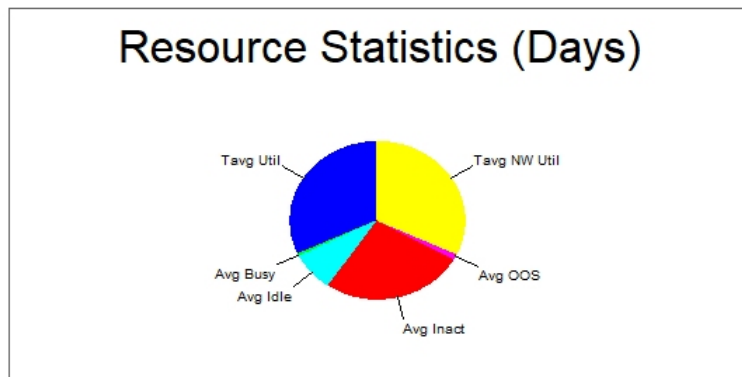
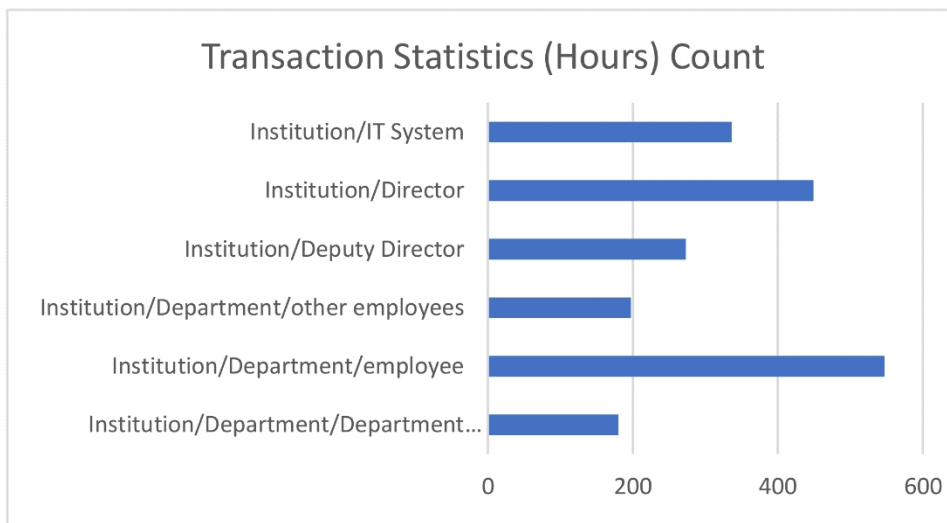
Table 2. Aggregate characteristics for various activities in the iGrafx environment (source: own study).

Activity Statistics (Hours) (15 of 26 rows)					
	Count	Avg Cycle	Avg Work	Avg Wait	Avg Serv
Institution/Department/employee -	1403	0	0	0	0
Institution/Department/employee - Who runs the process?	1402	0,06	0,06	0	0,06
Institution/Department/employee -	1352	0	0	0	0
Institution/Department/other employees - Is internal document agreed with other people?	981	0,06	0,06	0	0,06
Institution/Department/Department Manager -	710	0	0	0	0
Institution/Department/other employees - Approval of document by designated persons	465	6,17	1,16	5	1,16
Institution/Director - Is document rejected?	421	0,06	0,06	0	0,06
Institution/Department/Department Manager - Acceptance of document	238	28,9	0,16	29	10,3
Institution/Department/Department Manager - Is accepted 2 ?	238	0,06	0,06	0	0,06
Institution/Deputy Director - Canceled	211	0	0	0	0
Institution/Director - redirect document to employee?	210	0,06	0,06	0	0,06
Institution/IT System - Save to Knowledge Base	202	0	0	0	0
Institution/Department/Department Manager - To whom to refer for approval?	143	0,06	0,06	0	0,06
Institution/IT System - Sent e-mail about document in rejection to employee who runs process	134	0,02	0,01	<0,01	0,01
Institution/IT System - canceled	134	0	0	0	0

We can also show several other aggregate statistics relating to the activities in the process of internal electronic documents flow. Such a summary in the form of a bar chart is shown in Fig. 8.

Table 3. The degree of resources usage in process in the iGrafx environment (source: own study).

Resource Statistics (Days)									
	Count	Labor/Person					Avg Res Wait	Avg Cost	Tot Cost
		Tavg Util	Avg Busy	Avg Idle	Avg Inact				
Institution/Department/Department Manager	1	96,51	1,6	0,06	5,13	0	8780,00 \$	8780,00 \$	
Institution/Department/employee	24	7,09	0,1	1,55	5,13	0	2050,83 \$	49220,00 \$	
Institution/Department/other employees	272	5,34	0,1	1,58	5,13	0	0,00 \$	0,00 \$	
Institution/Deputy Director	1	43,41	0,7	0,94	5,13	0	12150,00 \$	12150,00 \$	
Institution/Director	1	95,17	1,6	0,08	5,13	0	15330,00 \$	15330,00 \$	
Institution/IT System	1	4,85	0,1	1,59	5,13	0	0,00 \$	0,00 \$	

**Figure 7:** Aggregated resources characteristics in iGrafx platform (source: own study).**Figure 8:** The chart of internal electronic documents flow time characteristics (source: own study).

CONCLUSION

The article shows how to model and simulate the process describing the flow of internal electronic documents in the organization. The process was presented in the form of a business process. The constructed process and its equivalent in the Low-code environment allow for simulating the functioning of the internal electronic documents flow process and obtaining results for various values adopted in the model of characteristics. This gives the opportunity to examine the properties of flow of internal electronic documents, find bottlenecks, lack of appropriate resources, etc.

An interesting aspect of the application of business process modeling and computer simulation in the Low-code environment to determine the characteristics of a real process was shown. The natural consequence of this is the constant development of the model in the organization and the implementation of subsequent modifications of the process to obtain the appropriate values of its efficiency indicators.

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