

# Management Processes Informative Modeling at the Project Development Stage

Lubomyr Petryshyn<sup>1,2</sup>[0000-0003-4168-3891], Mykhailo Petryshyn<sup>2,3</sup>[0000-0001-6319-3768],

Agnieshka Choczynska<sup>1</sup>[0000-0002-0310-4177]

<sup>1</sup> AGH University of Science and Technology, Mickiewicza str. 30, 30-059 Cracow, Poland

<sup>2</sup> Vasyl Stefanyk Precarpathian National University, Shevchenko Str. 57,  
76018 Ivano-Frankivsk, Ukraine

<sup>3</sup> University of Lodz, Narutowicza str. 68, 90-136 Lodz, Poland  
l.b.petryshyn@gmail.com, m.l.petryshyn@gmail.com,  
achoczyn@zarz.agh.edu.pl

**Abstract.** Management process modeling in the context of intersectoral cooperation based on distributed information systems allows to reduce costs of development and exploitation of such complex systems. The proposed technique of process analysis allows to decompose the overall management system process as well as visualize of information models and graphical representation of processes and simplifies the understanding at the analysis and design stage between the customer and the system developer. The system analysis bases and a simplified management system development example of the online publishing network are presented.

**Keywords:** Process Analysis, Visualization Modeling, Information Processes, Sectoral Cooperation, Distributed Systems, Management, Algorithm.

## 1 Introduction

The need to improve the management efficiency of distributed information systems requires the usage of information technologies that provide a reflection of the system state and the management system processes in real-time [1].

Analysis and visualization of management processes allows to avoid the psychological barrier, ambiguity, confusion and misunderstandings between client and developer of information system and also reduce the cost of development, implementation, and maintenance of such complex systems [2-4].

The goal of the project is to develop information models of customer relationship management systems based on the project documentation on demand for online publishing. The enterprise structure is analyzed, defined the research problems and proposed the methods of problem solving, specification of processes, functional and non-functional requirements.

The novelty of the work is in presentation the technique of system analysis by following international standards [5-9], which, with its implementation into the process

of information system modeling provides visualization of management processes and simplifies the structure understanding.

The practical meaning is in a comprehensive analysis of the structure and course of management processes, avoiding misunderstandings in formulating the task and providing customer requirements and also reducing the development and exploitation cost of management systems. A simplified example of management system relation with clients in online publishing was developed in this project.

Online publishing is a medium-sized enterprise that provides a wide range of publishing services. Collaboration with customers and orders fulfillment are executed via the Internet, finished products are sent to customers by mail or courier. The company owns a fleet of printing machines and a team of graphic designers, who prepare orders for printing and creating a graphic layout in accordance with the requirements formulated by the customer.

The basics of visual modeling have been published in [9]. Let's analyze a simplified example of system process analysis according to the requirements [6, 10-13] during the modeling of a distributed management system in order to simplify and facilitate performing a specific order according to client needs at the current time.

The problem of research is that clients do not have the appropriate level of knowledge in printing techniques, so they are not always able to place an order that can be executed in the desired quality.

The solution for this problem is in implementation of information provision that will allow customers and graphic designer to work together on the final version of the order, viewing the files, making changes, accepting versions, and posting comments.

The basics of visual modeling have been published in [9]. Let's analyze a simplified example of system process analysis according to the requirements [6, 10-13, 18-20] during the modeling of distributed management system in order to simplify and facilitate the potential client to perform a specific order according to his needs at the current time.

The problem of research is that clients do not have the appropriate level of knowledge of printing techniques, so they are not always able to complete an order that can be executed in the desired quality.

The solution to this restriction is in implementation of information support that will allow customers and print staff to work together on the final version of the order, viewing the files, making changes, accepting versions, and posting comments.

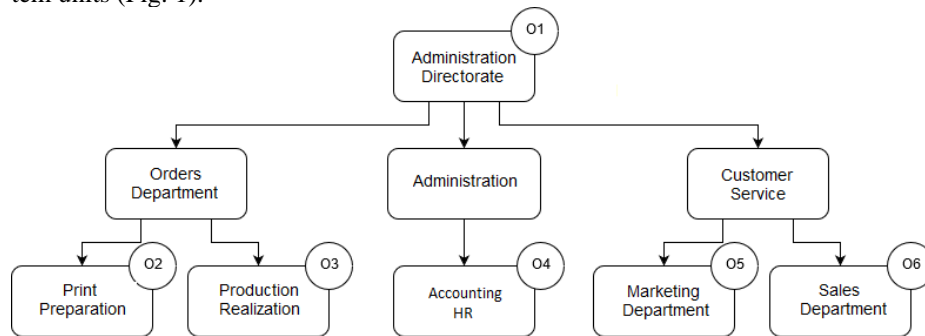
The purpose of the system implementation is to provide the following factors:

- reducing complaints and costs;
- inclusion the customer in the process of quality control of the order fulfillment, which will satisfy their demand and in the future will stimulate to place another orders;
- quality assurance of the provided services;
- simplifying the graphic designers work by fulfilling the client's expectations and wishes;
- reduction of terms of non-communication with the client.

In order to define system functions, we analyze the structure of organizational units in management system [7, 10].

## 2 Analysis of the Management System Components

The organizational structure of the management system consists of the following system units (Fig. 1).



**Fig. 1.** Structure of organizational management system.

O1 The enterprise management controls the progress of the production and management process, engages in the logistics of ensuring processes to achieve the maximum technical and economic enterprise efficiency.

O2: The printing department controls the quality of files received from the client, their correction, and the reconciliation of prepared templates for printing with the client.

O3: Manufacturing of the enterprise perform production and maintenance of equipment.

O4: Accounting and HR Management.

O5: The marketing department cooperates with clients, creates promotional packages, shapes the company image. Organizes promotions and develops marketing strategies aimed at attracting new customers and retaining regular customers. Collects and analyzes information to ensure optimal quality of service.

O6: The sales department deals with receiving and processing orders, negotiating and delivering goods. Collaborates with the marketing department and analyzes customer complaints.

The modeled system provides a comprehensive online ordering service for print products with delivery to the specified address. The models are implemented as the interacting modules shown on Fig. 1.

## 3 User's Functional Requirements Analysis

Functional user's requirements are the main factors in the composition of system operations in the management system, its architecture and software [5, 6, 8, 13]. An

analysis of the experience of using similar systems allowed us to determine the following list of user requirements.

[FUNO1] The system allows the user to log in, access and edit the documents to which the user has the rights assigned to the respective roles.

[FUNO2] The following roles and privileges are defined in the system:

- client – can place an order, send messages, access to the project in the form of read-only and approval the project version;
- schedule - the ability to send a message, access the project in edit mode and send the project for print;
- manager - send messages, read-only access to the project and access to statistics related to the project preparation process (for example, the number of hours spent on the project by individual users.

[FUNO3] The system directs the customer's order to the manager.

[FUNO4] The system allows the manager to include in the project any number of graphic images available in the system.

[FUNO5] Only the client who placed the order, all system managers and graphic designers assigned to this project can access the project

[FUNO6] The system allows a manager to withdraw from a graphic designer project that was previously assigned to him.

[FUNO7] The system allows to print only a project approved by the customer.

[FUNO8] The system provides the ability to store the history of created reports and processed files.

[FUNO9] The system allows:

- preview high-resolution image files (in read mode);
- Uploading image files in the following formats: .png, .pdf, .jpg, .psd, .xcf;
- processing image files in the following formats: .png, .pdf, .jpg, .psd, .xcf;
- archiving of projects;
- deleting files or projects;
- renaming files and folders;
- view file and folder properties.

## **4 User's Non-Functional Requirements Analysis**

The following non-functional requirements are formulated to hardware and software in the management system's [5, 6, 14].

[NFO1] Subject to the granting of an additional license by the contractor, it's using have to be indefinite.

[NFO2] The contractor provides guidance on the operation of the developed system to monitor data flows.

[NFO3] The Customer is the sole proprietor of the developed solutions and licenses provided by the contractor, as well as all solutions and processes specifically tailored to the requirements of the system.

[NFO4] The system should provide simple and fast information exchange based on network technologies, as well as the transition to new versions or another server.

[NFO5] Configuring system privileges must be in accordance with the principle of minimum privileges.

[NFO6] The system has to monitor communication errors, generate error information as a log in .txt format.

[NFO7] The system provides constant access to resources temporary break is only allowed when new versions of the system are introduced. It must be possible to restore the system before upgrading or crashing

[NFO8] The system must be capable of reconfiguring and embedding new services without interfering with other modules or system operations.

[NFO9] The system must have software that is configured to provide high availability of services and the ability to use components of the above software that are resilient to failure of one server or module that is a component of the system to increase its reliability.

Based on formulated user requirements, the system management process was decomposed into two processes: order execution and calculation of order execution cost.

## 5 Definition of System Operations in the Management Process

The result of the decomposition of control system processes is the definition of system operations [7], the composition of which for two processes is given in tables 1 and 2.

The identified system operations are ordered and scheduled to be performed in the overall management process according to the following graphical models.

## 6 Information Modeling of Management Processes

The matrix model of the overall system management process reflects two customer-defined processes (fig. 2): order fulfillment and cost estimates of the order implementation. This model allows to visualize the performance of individual system operations in the relevant units on a timeline [6, 7, 9, 14, 15]. Each cell defines the type of system operation (DX), the unit in which it is executed (OY). Start time is shown in the upper left corner, duration of execution - in the upper right corner, information sharing time is above the arrows, as well as the network of system links indicated by the arrows.

**Table 1.** System operations as part of the process "Order fulfillment".

Order fulfillment				
Documents	Unit	Description	Duration	Requirements
D1 [ordering]	O6	Reception of the client's order	1	FUNO3

				FUNO4
D2 [analysis]	O2	Analysis of project complexity and cost estimate	2	FUNO2
D3 [order for employees]	O1	Resource planning	1	FUNO4 FUNO6
D4 [ordering]	O4	Missing materials order	1	FUNO2
D5 [notification]	O2	Notify the client of the necessary corrections	3	FUNO2
D6 [file to print]	O2	Making corrections and preparing to print	6	FUNO2 FUNO9
D7 [product]	O3	Printing	3	FUNO7
D8 [invoice]	O6	Shipment the order to the client	2	

**Table 2.** System operations as part of the process “Estimated costs of the order implementation”.

Estimated costs of the order implementation				
Documents	Unit	Description	Duration	Requirements
D9 [valuation]	O6	Estimated valuation	1	FUNO2
D10 [estimate]	O4	Estimation of material correction costs	3	FUNO2
D11 [sale price]	O4	Accrual of discounts	1	FUNO2
D12 [the final price]	O4	Shipping cost calculation	1	FUNO2
D13 [price inf.]	O6	Transfer the invoice to the customer	1	FUNO2














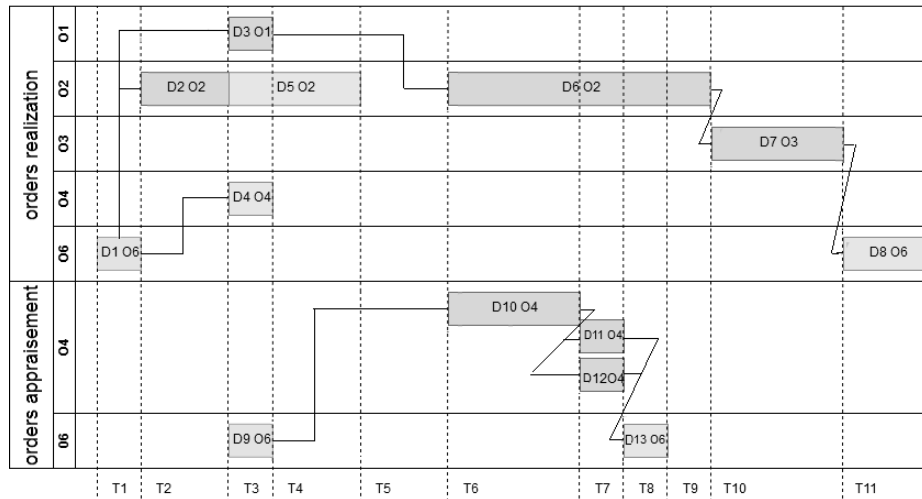
Documents	Enterprise Departments					
	O1	O2	O3	O4	O5	O6
D1						0  1
D2		1  2				
D3	3  1					
D4				4  1		
D5		4  3				
D6		4  6				
D7			10  3			
D8						13  2
D9						0  1
D10				1  3		
D11				4  1		
D12				5  1		
D13						6  1

Fig. 2. Matrix model of the management system.

Model type "Network graph" (Fig. 3) is the basic, derivative of the Gantt model [4, 9, 14], allows to switch to UML modeling and presents the following basic system parameters, as the start and end times of system operations, their implementation in units, as well as the structure of the system and communication channels.



**Fig. 3.** Model "Network graph".

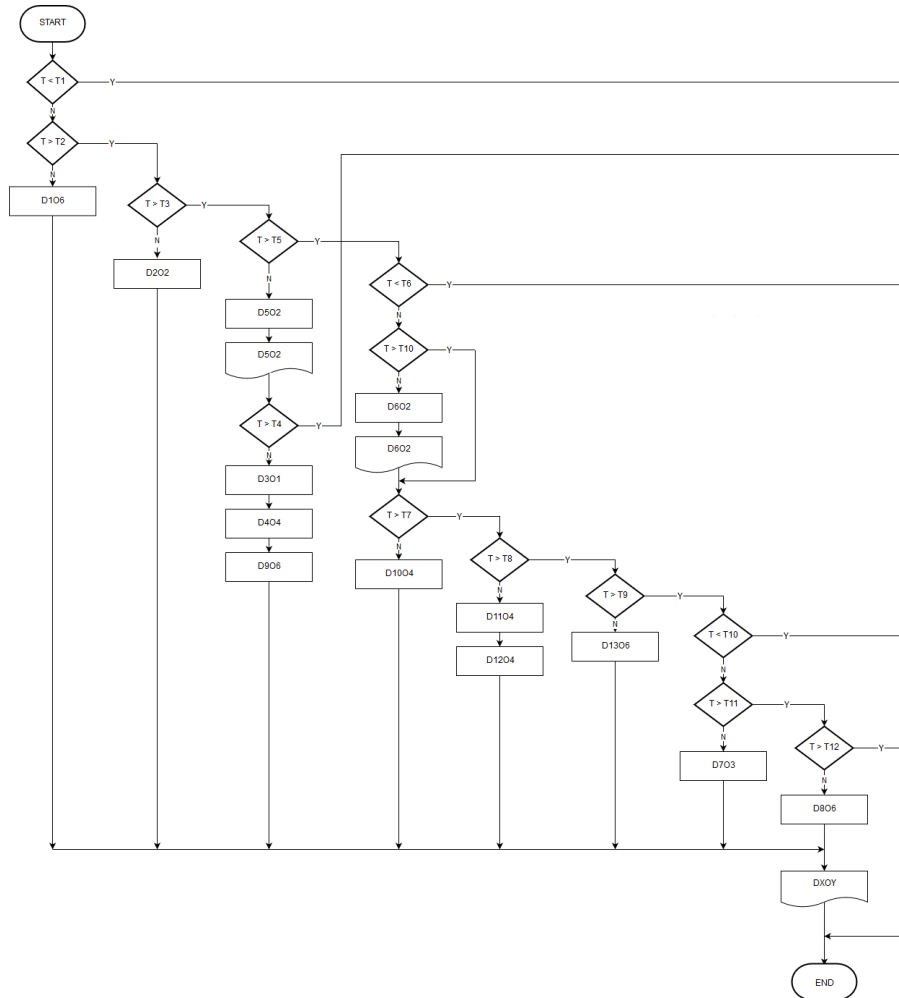
Based on the network graph model, a block diagram of the algorithm of the system operations program was constructed (fig. 4), which, based on object-oriented programming, allows for rapid implementation and implementation of management system application software [7, 10, 14, 15].

## 7 Management Processes Simulation

The process is simulated using the online BPSimulator program, located at <http://www.bpsimulator.com> [16]. Below is a model, built to simulate the control process (fig. 5) based on previous information models and BPSimulator generated report (fig. 6). The simulation results made it possible to evaluate the performance of the management system software and determine the average lead time of the process [17].

Based on the simulation results, the developer is able to perform visual modeling of business processes, identify "narrow" areas of productivity, estimate the time and cost of operations, to select and justify the optimal variant of the management process organization.





**Fig. 4.** Flowchart of the algorithm for performing system operations.

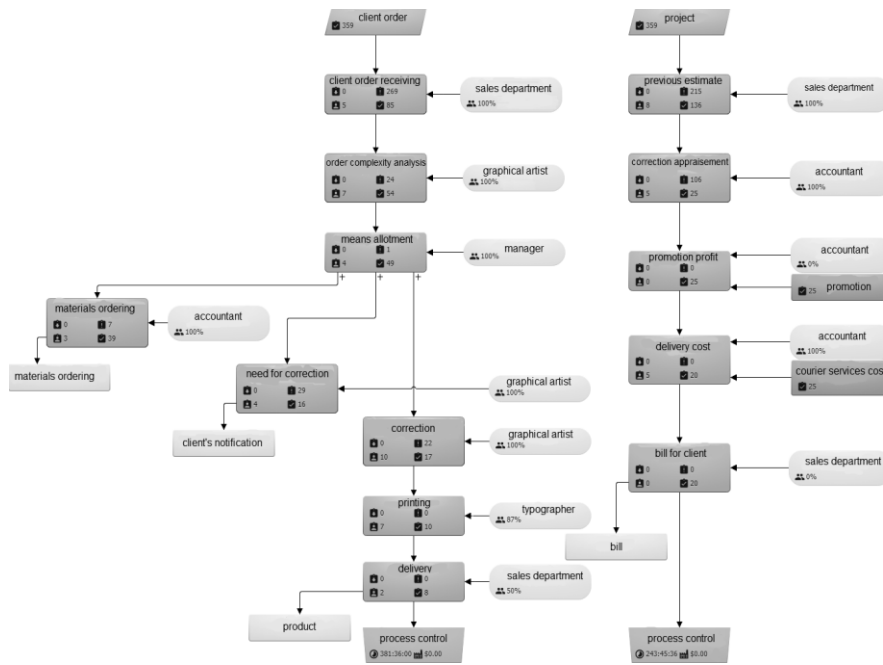
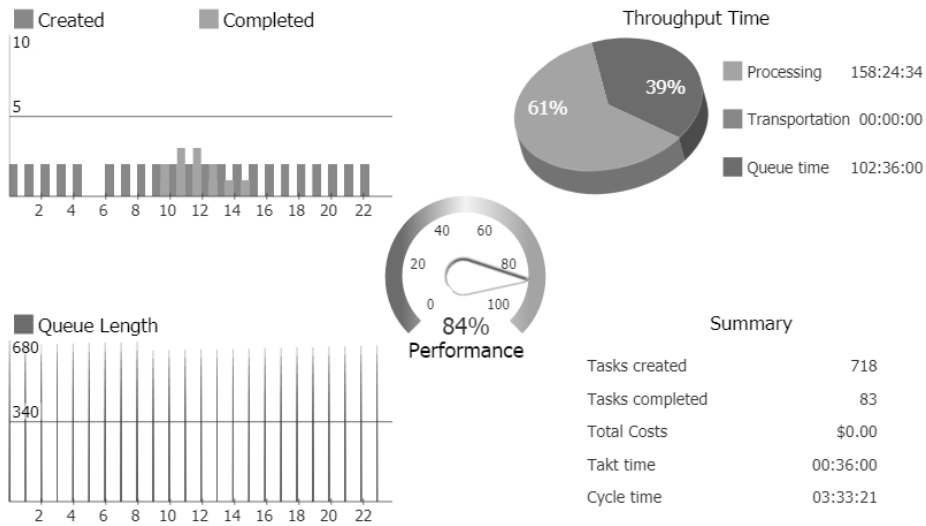


Fig. 5. Simulation model of functioning of control system.



www.bpsimulator.com

Fig. 6. Report of the simulation load on the management information system.

## 8 Conclusions

The article presents information models of online publishing management support system with decomposition of customer relations processes. The models are built according to the standards IEEE/ISO/IEC [5-8, 10-15, 17], allowing further analysis and identification of critical points in the system. The basic functional and non-functional requirements necessary for system implementation are identified.

Based on the developed methods that visualize the course of complex control systems, the modeling basics are determined, which made it possible to represent the process progress and manage the information system in real time. Methods and technique of visualization of control processes are presented, which eliminates the psychological barrier and avoids mutual misunderstanding between the client and the information system developer, and reduce the cost of developing, implementing, and maintaining distributed management systems.

The goal of the project has been achieved, which consisted in system analysis and construction of information models of management process by the example of online publishing. The decomposition of the system based on the analysis of real processes is carried out. System implementation can optimize costs, improve service quality, and automate system processes.

Implementation of the developed system allowed to improve the quality of information exchange between customers, separate units and go to an automated control system. Making changes in the system leads to increasing competitiveness of the company, and the system's functionality is tailored to market requirements

## References

1. Morozov, V. V., Kalnichenko, O. V.: The study of processes interaction models in IT-projects based on proactive approach]. Bulletin of NTU "KhPI". Series: Strategic Management, Portfolio, Program and Project Management, 2 (1327), 20-27 (2019).
2. Chernova, L. S.: Structural model of management system of development programs at the enterprise. Bulletin of NTU "KhPI". Series: Strategic Management, Portfolio, Program and Project Management, 2 (1327), 50-59. (2019).
3. Petryshyn, L., Cyeslik, V., Petryshyn, M.: Processes visualization modeling in distributed management systems. In Intelligence Systems and Information Technologies: International Scientific and Practical Conference ISIT-2019. August 19-24, 2019, Odessa, Ukraine. Odessa: TES, pp. 155-159 (2019).
4. Petryshyn, L., Rogóz-Duda, A., Petryshyn, M.: Visualization modeling of integrated management systems. In: proceedings of the 8-th International Scientific and Technical Conference Information Systems and Technologies IST-2019, Kobleve-Kharkiv, Ukraine, September 09-14, 2019. Kharkiv: KhNURE, pp. 9-14. (2019).
5. IEEE 830-1998 Recommended Practice for Software Requirements Specifications.
6. IEEE 1233-1996 Guide for Developing of System Requirements Specifications.
7. IEEE 1362-1998 Guide for Information Technology – System Definition – Concept of Operations (ConOps).
8. 29148-2011 - ISO/IEC/IEEE International Standard - Systems and software engineering - Life cycle processes -Requirements engineering.

9. Petryshyn L., Nykolajchuk Ya., Analytical modeling of infosystems of automated management. In Zarządzanie organizacjami w gospodarce rynkowej: X międzynarodowa naukowa konferencja "Zarządzanie przedsiębiorstwem. Teoria i praktyka": Kraków, 22-23 listopada 2007 r. Kraków: Wydawnictwa AGH (2007).
10. ISO/IEC TR 19759:2015 Software Engineering — Guide to the software engineering body of knowledge (SWEBOK).
11. ISO 15288 System Life Cycle Process.
12. ISO/IEC 15504 Software Process Improvement and Capability Determination.
13. IEEE 1498-1995 - EIA/IEEE Interim Standard for Information Technology - Software Life Cycle Processes - Software Development: Acquirer-Supplier Agreement (Issued for Trial Use).
14. IEEE 1042-1987 (Reaff 1993), IEEE Guide to Software Configuration Management (ANSI).
15. IEEE 1002-1987 (Reaff 1992), IEEE Standard Taxonomy for Software Engineering Standards (ANSI).
16. BP Simulator, <https://www.bpsimulator.com/run/>, last accessed 2019/12/09.
17. IEEE 1045-1992, IEEE Standard for Software Productivity Metrics (ANSI).
18. Shestakevych, T., Pasichnyk, V., Kunanets, N., Medykovskyy, M., Antonyuk, N. The content web-accessibility of information and technology support in a complex system of educational and social inclusion. In: proceedings of 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2018, vol. 1,8526691, pp. 27-31 (2018).
19. Veretennikova, N., Pasichnyk, V., Kunanets, N., Gats, B. E-Science: New paradigms, system integration and scientific research organization. Proceedings of the International Conference on Computer Sciences and Information Technologies, 7325436, pp. 76-81. (2015).
20. Bomba, A., Kunanets, N., Nazaruk, M., Pasichnyk, V., Veretennikova, N.: Information technologies of modeling processes for preparation of professionals in smart cities. Advances in Intelligent Systems and Computing 754, 702-712 (2019).