UDC 004.94

AUTOMATED WORKFLOWS FOR ASSESSING THE QUALITY OF FUNCTIONING OF SCIENTIFIC AND EDUCATIONAL INSTITUTIONS

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Background. The effectiveness of functioning is a particularly important characteristic for organizations involved in the field of science and education, since the future level of state development and the life of its citizens depends on the quality of the services they provide. There are certain generally accepted principles of such organizations evaluation that is set by relevant normative documents. Nowadays important tasks are optimization and automatization of such processes.

Objective. The aim of the paper is to propose and develop a workflow model for automating and optimizing the procedure for evaluating scientific and educational institutions.

Methods. We use approaches to business process modelling and basic principles of workflow modelling, namely BPMN notation was chosen as the notation to model elements of workflows for assessing the quality of scientific and educational institutions functioning, and Camunda Modeler was used as the development environment.

Results. Conceptual model of the work process for assessing the quality of scientific and educational institutions functioning was proposed, which made it possible to generalize and formalize such an assessment process. Developed using BPMN models of workflow were used to test proposed conceptual model and prove its effectiveness for automating the process of assessing the quality of scientific and educational institutions functioning.

Conclusions. Mechanism of modelling the process of assessing the quality of scientific and educational institutions functioning proposed in the paper gave basis and means for such process optimization and automatization.

Keywords: workflows; quality assessment; scientific and educational institutions; BPMN model.

Introduction

Nowadays, there are a large number of public and private institutions that provide services in various spheres of society's life. The demand for such institutions directly depends on the efficiency of their functioning. The effectiveness of functioning is a particularly important characteristic for organizations involved in the field of science and education, since the future level of development of the state and the life of its citizens depends on the quality of the services they provide. That is why today there are certain generally accepted principles of evaluation of such organizations. The process of such an expert assessment is given and approved in the relevant normative documents. At the moment, there is a need for solved problems of optimizing the use of labour in organizations that accredit state scientific structures. Optimization of such processes will help to evenly divide official duties and algorithmize the structure of work.

To solve this problem, the work proposes a method of optimization and automation of work on accreditation of scientific institutions. The proposed model of the workflows will increase the effectiveness of the assessment of the quality of the functioning of scientific and educational institutions. The final model can be adjusted and appropriate technical solutions can be chosen for its implementation.

The main goal of the study was to propose and develop a workflow model for automating and optimizing the procedure for evaluating scientific institutions, namely:

1. To conduct an overview of the methods and means of modelling workflows.

2. Conduct a comparative analysis of workflow simulation tools.

3. Identify the characteristic features of the process of assessing the quality of functioning of scientific and educational institutions.

4. To highlight and describe the elements and stages of the workflow of the functioning of scientific and educational institutions.

5. To propose a workflow process for assessing the quality of functioning of scientific and educational institutions.

6. Model the workflow of assessing the quality of functioning of scientific and educational institutions in the appropriate software environment.

Concept of workflows

Workflow is a scheme for organizing the sequence of tasks within a single service provided to end users [1]. Such a scheme is aimed at simplifying and accelerating (mainly) common business processes that are repeated and have a clear execution structure, such processes can be automated using the Workflow method, for example: bill payment, purchase of goods, processing of an incoming request from a client.

A workflow may include associated computing sub-processes, information dependencies, decision-making sequence, performing some calculations [2, 3].

The route of the workflows or its part in most programs is presented in the form of a graphic block diagram. Responsible employees and managers monitor the flow of work and can trace at which stage delays most often occur and which of the chain participants really slows down the process. The system itself monitors temporary limits. Overdue tasks are highlighted, trigger pop-ups with reminders, or inform the initiator of the issue. At the same time, the system can analyse indicators and indicate abnormal indicators.

When setting up the algorithms in the program, it is important to remember that the automation of the process does not happen immediately, and you need to allocate time to develop an algorithm that will work effectively. Despite the fact that only those business processes that are allocated and structured can be automated using workflow technology, the transfer of the structure to the system settings requires the participation of all responsible employees and management staff [4].

Overview of approaches to workflows automation in information systems

To display the flow of work, a block diagram or a graph is used, which consists of operations (functional services), logic symbols, and the structure of connections [3, 5]. The sequence of calculations is indicated by arrows between blocks of operations. Workflow (from an information point of view) is a way of presenting information to various objects of the work process that participate in it directly or indirectly.

Typically, a workflow model can be described using the formal or informal techniques of flowcharts, which show directed flows between processing steps.

Business process models can be hierarchical because the operations in the model can be described in terms of a more detailed process (specification, concept), commonly known as decomposition.

Processing steps or workflow components can be basically defined by three parameters [6]:

– Input Description: Information, data and resources required for the workflow.

– Transformation rules: algorithms that can be executed by a human, a program, or both.

– Output description: information, data and resources processed by the workflow and ready for transfer to subsequent services.

Components can be combined only if the output information of one component corresponds to the input information of the next component and also satisfies the conditions of the subject area.

Thus, the semantic description must necessarily include a description of the input and output data and a meta-description of the functional services performed in this workflow [7].

If there are several methods (functional services) of processing the same data, then you need to add a meta-description of the algorithms that perform a given function, and it is also desirable to specify the characteristics of the performance of the given functions, such as: accuracy, speed, and others.

This is due to the fact that the information operated by the workflows is weakly connected and differently structured and can be processed by different methods depending on the characteristics of the input data flow. But from the point of view of data processing, the information needs to be structured and the system trained on specific data to be able to use different methods more effectively.

Table 1 shows approaches that are used when modelling methods of business processes. They are classified according to three main perspectives of work processes.

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Table 1. Approaches to modelling work processes

Control-flow perspective	Data perspective	Resource perspective
BPMN UML Activity Diagrams Petri nets State charts EPCs	UML class diagrams ER diagrams Object-role models	Use cases Role-activity diagrams Organizational charts X.500

The most common methods for modelling work processes are:
− Petri nets
− Workflow nets
− EPCs
− BPMN notation

Table 2. Methods of modelling workflows

Notation	Logical operations	Temporal determinism	A wide range of designs	Relevance among developers
Petri	-	+-	-	-
Workflow	+	+	+-	-
EPCs	+	-	+-	-
BPMN	+	+	+	+

Table 2 schematically presents a comparative analysis of the methods used in the modelling of workflows. The comparison was made according to the following criteria:

1. A set of logical operations used during simulation
2. Temporal determinism
3. A set of formal constructions used in modelling
4. Relevance of using the method

Thus, as can be seen from the table. 2, the BPMN notation satisfies the largest number of criteria. Therefore, it was chosen as the basis for the development of a work process model for assessing the quality of functioning of scientific and educational institutions. It is the BPMN notation that demonstrates the deep integration of the workflow development environment and has a large set of objects for describing the workflow.

A model of the workflows for assessing the quality of functioning of scientific and educational institutions

The process of assessing the quality of the functioning of institutions in Ukraine is regulated by three national regulatory documents:

− «Regulations on state certification of research (scientific and technical) institutions»,

− «Methodology for optimization of budgetary scientific institutions, that are fully or partially financed from the state budget»

− «The procedure for evaluating the development of the activity of a scientific institution, approved by the Cabinet of Ministers of Ukraine».

Characteristic features of the procedure for assessing the quality of the functioning of scientific and educational institutions are its complex structure, multi-stage nature and the presence of a large number of objects and subjects that participate in such an assessment. Such features must be taken into account in the corresponding formalized work process. Accordingly, in the work process of assessing the quality of functioning of scientific and educational institutions, the following main points were highlighted:
− Workflow objects
− stages of the workflow
− elements of the workflow

In the procedure for assessing the quality of functioning of scientific and educational institutions, described in documents [8], these entities correspond to:

− elements of the workflow – structures that take part in the evaluation procedure (Presidium of the National Academy of Sciences of Ukraine, Standing Commission of the National Academy of Sciences of Ukraine for the Evaluation of the Performance of Institutions (SC), Standing Commissions for Scientific Areas (SCSA), Expert Commissions (EC), Office for the Evaluation of Scientific Activities institutions, Object of evaluation: scientific or educational institution - here in after the Institution). The corresponding listed elements are closely related by the sequence of interactions at different stages of the assessment procedure.

− objects of the workflow – documents (documents of external circulation: recommended lists, reports on work performed and documents of internal circulation: regulated questionnaires for evaluation), presentations, databases.

− stages of the workflows – direct stages of the assessment procedure, which are specified by

regulatory documents. The procedure for evaluating the Institution's activity consists of three stages.

1. At the first stage, the EC gets to know the Institution's activities, analyses its questionnaire and the objectivity of the materials provided by it, conducts interviews with the Institution's employees. Based on this and in accordance with the evaluation regulations, the EC draws up its conclusion within two weeks from the date of the visit and submits it together with the questionnaire of the institution to the SCSA.

2. At the second stage, based on the materials received from the EC and their analysis, the SCSA prepares a presentation on the activities of the Institution, the draft of which is agreed with the EC and submitted to the Institution for perusal.

The task of the presentation is to provide a concise and objective assessment of the activities of the Institution and its divisions. SCSA transmits the conclusion of the EC to the Institution.

After reading the conclusion, the Institution submits its statement to the SCSA regarding the conclusion of the EC. On the basis of the conclusion of the EC and the application of the SCSA Institution prepares a draft report on the evaluation of the effectiveness of the Institution's activities and recommendations on its

Using all identified and described elements we have designed Conceptual model of the workflow for assessing the quality of functioning of scientific and educational institutions.

The conceptual model does not correspond to any notation, and is designed for a structural representation of the work of the finished system. In this model, it is assumed that all subjects interact within one web resource (information environment).

The process corresponds to the general flow of workflow actions, i.e. it does not display additional structures (sub-processes). Also, the problem of such a display is that it is poorly structured and lacks a clear division into stages. This is due to the fact that if you consider all sub-processes not separately, but on the general scheme, then it will be too large, overloaded and difficult to perceive. Such a conceptual model is the first step in the modelling of work processes, it is the basis for the development of work process diagrams using appropriate notations.

further activities for the SC. SCSA submits to the SC: the conclusion of the EC, the questionnaire, the evaluation package and the statement of the Institution, the presentation of SCSA, the draft report of the SC and recommendations.

3. At the third stage, on the basis of the materials received from the SCSA and their analysis, the SC considers a draft report on the evaluation of the effectiveness of the Institution and after consulting with the SCSA and, if necessary, with the EC, approves it with the subsequent submission of such a report and recommendations for further activities of the Institution to the Presidium of the National Academy of Sciences of Ukraine. The SC publishes on the web portal of the National Academy of Sciences of Ukraine: a certificate on the assessment of the effectiveness of the Institution's activities; presentation of the Institution. All parties involved in the evaluation procedure must maintain confidentiality until the relevant materials are made public.

4. On the basis of the considered stages of the assessment process and the elements that participate in it, a conceptual model of the workflow of assessing the quality of the functioning of scientific and educational institutions   was   developed.

Modelling the workflow of assessing the quality of functioning of scientific and educational institutions

The BPMN notation was chosen as the notation for modelling the workflows of assessing the quality of functioning of scientific and educational institutions, and Camunda Modeler was used as the development environment [9]. Camunda Modeler is a BPM environment for automating workflows. Its advantages include [10]:

− The open code allows you to clearly understand how the software works, and the documentation allows you to quickly understand how to integrate the engine into your infrastructure.

− Camunda supports the latest version of Java, or indeed any JVM language.

− Architecture inside - the engine does what is expected of it in the most obvious and expected way. There are no extra abstractions to learn.

− Convenience of development, testing and embedding in CI \ CD due to the fact that Camunda can be used simply as a library in a Java application. Camunda does not limit the developer with any of its terms.

− Statistical analysers, test frameworks, assembly tools, version control tools.

The developed workflows models (Fig. 1, Fig. 2) for quality assessments of scientific and educational institutions functioning allow to automate the procedure of such an assessment, increasing the efficiency of its execution, due to the reduction of time for its implementation, and also provide the possibility of integrating the received data from BPMN notation into third-party applications and information systems in an automatic format.
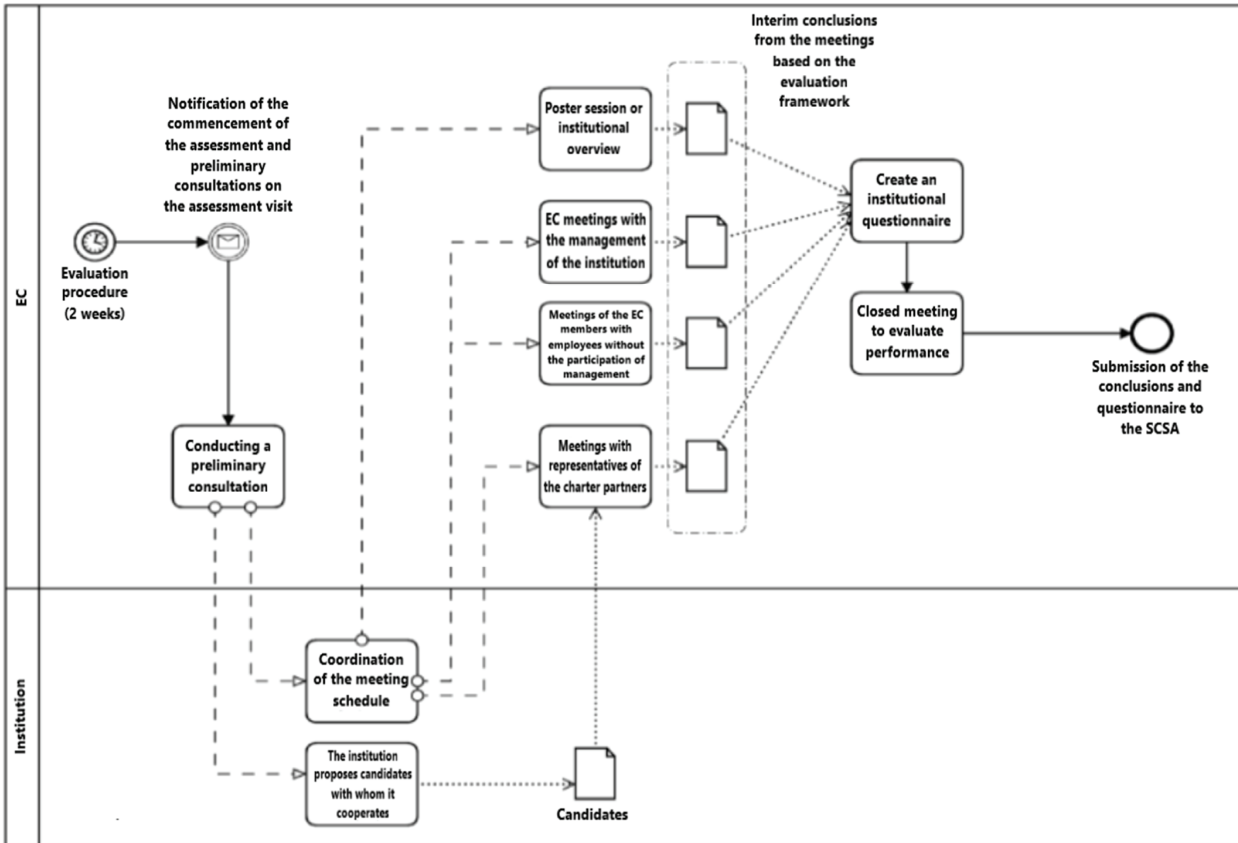

Fig. 1. Generalized scheme of the general workflows of assessing the quality of functioning of scientific and educational institutions
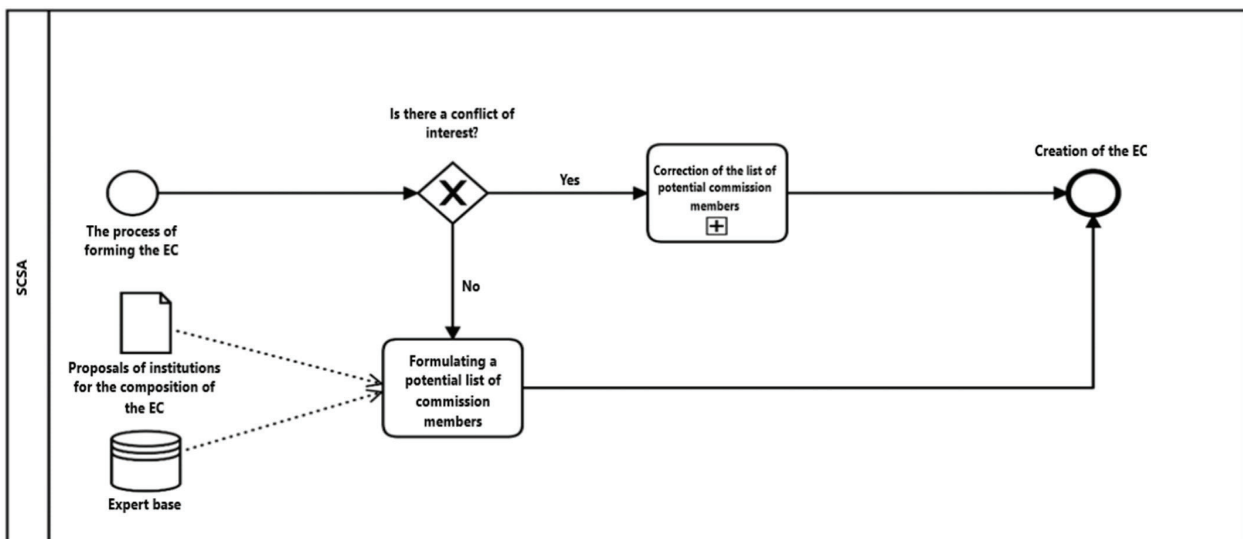

Fig. 2. Generalized scheme of the general workflows of assessing the quality of functioning of scientific and educational institution

Conclusions

In the paper characteristic features of the procedure for assessing the quality of the functioning of scientific and educational institutions were identified and the key stages of such a process were formed. On this basis a conceptual model of the work process for assessing the quality of scientific and educational institutions functioning was proposed. Such an approach made it possible to generalize and formalize such a assessment process.

Workflow modelling was carried out in the Camunda Modeler software environment based on approaches to modelling work processes defined by the BPMN notation, which made it possible to test the proposed conceptual model and prove its effectiveness for automating the process of assessing the quality of scientific and educational institutions functioning.

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Автоматизовані робочі процеси оцінки якості функціонування наукових та освітніх установ

Актуальність. Ефективність функціонування є особливо важливою характеристикою для організацій, що працюють у сфері науки та освіти, оскільки від якості послуг, які вони надають, залежить майбутній рівень розвитку держави та життя її громадян. Існують певні загальноприйняті принципи оцінки таких організацій, які встановлені відповідними нормативними документами. Актуальними завданнями на сьогодні є оптимізація та автоматизація таких процесів.

Мета. Мета роботи – запропонувати та розробити робочу модель для автоматизації та оптимізації процедури оцінювання наукових і освітніх установ.

Методи. Ми використовуємо підходи до моделювання бізнес-процесів та базові принципи моделювання робочих процесів, а саме в якості нотації для моделювання елементів робочих процесів для оцінки якості функціонування наукових та освітніх закладів було обрано нотацію BPMN, а середовище розробки – Camunda Modeler.

Результати. Запропоновано концептуальну модель робочого процесу оцінки якості функціонування науково-освітніх закладів, що дало змогу узагальнити та формалізувати такий процес оцінки. Розроблені з використанням BPMN моделі wokflow були використані для тестування запропонованої концептуальної моделі та доведення її ефективності для автоматизації процесу оцінки якості функціонування наукових і освітніх установ.

Висновки. Запропонований у роботі механізм моделювання процесу оцінювання якості функціонування науково-освітніх закладів дав основу та засоби для оптимізації та автоматизації такого процесу.

Ключові слова: робочі процеси; оцінка якості; наукові та навчальні заклади; модель BPMN.