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SPECIFIC ANALYTICAL PERSPECTIVES IN THE MODELLING OF WORKFLOW SYSTEMS

Introduction

Workflow IT systems are becoming increasingly popular IT tools within the layer of enterprise application software. The interest in the systems of this type results from the evolution and popularity of the process-based approach to enterprise management and the evolution of the enterprise resource planning method with its IT support tools – ERP systems. From the 1970's enterprises have been using MRP/ERP systems, which initially supported manufacturing material requirements planning, then planning the demands on equipment, staff and finally, the enterprise finances. It can be stated that presently the operating processes, within which the materials, products, goods or money are processed, are supported by appropriate functionalities of ERP systems. It is high time to develop the support tools concerning processes which are not directly related to the means of production, but with the processes of immaterial workflow, information and decision flow. This area includes workflow systems discussed in this paper.

The workflow processes are the most complex and unstructured ones. Their complexity results from the fact that practically all employees of an enterprise participate in their implementation. Lack of structure results from the character of information and decision-making tasks. The examples of workflow processes include: project planning and control, preparation of sectional and consolidated budgets, processes of issuing operating decisions, for instance, approval of costs, commercial conditions, processes of periodic employees' appraisal or, finally, processes carried out within team work, for example, preparation of offers or contracts. To assure effective implementation of the workflow system in an enterprise, a thorough business analysis and organisation, and very often reorganisation of processes, must be performed first. The theory of analyses and design of informa-

tion systems (IS) provide many analytical methodologies and tools, however, according to the experience of authors, there are perspectives which are very significant for the workflow systems, but which are not sufficiently taken into consideration. The paper indicates the perspectives of organisational structure, localisation structure, enterprise rules and concepts as the elements essential for the complete model of the workflow processes. The aim of this paper is to show the meaning of these perspectives and pointing out author's analytical tools needed for building of workflow system's model. The first part of the work discusses the basic concepts concerning workflow and presents the assumptions of an independent methodology of analysis dedicated to this type of systems. This methodology includes the above-mentioned additional and specific analytical perspectives. Further part provides a more detailed description of the said perspectives and suggests analytical tools which may be used in their description. The last part of the paper presents the practical use of the discussed perspectives and tools. Scenario of the example was based on the assumptions of the analytical project in which the author participated; also the proposed methodology was used. Identification data of the organisation was changed for the purposes of this paper. The proposed modelling perspectives of workflow systems form the basis of a complete analytical methodology codenamed SPARD. The methodology will be discussed in further author's works.

1. Basic concepts concerning workflow systems

The idea of workflow systems goes back to philosophical and linguistic considerations from the 1960's [ĆWIK06]. Current research within this field is focused on the modelling and designing of IT tools supporting the work and information flow in organisations. Presently many academic and business institutions work on the subject of workflow systems. A few organisations for standardisation were established with regard to the variety of theoretical and practical approaches. Workflow Management Coalition (WfMC) is the best known among them. WfMC unifies the concepts and establishes standards concerning workflow systems. The publication of a dictionary of concepts and terminology regarding workflow [WFMC99] is a significant achievement of this organisation. The glossary created by WfMC is one of the main sources of terminology on which the scientific and technical works are based. For the purposes of this paper the translation of such concepts as workflow, workflow system and definition of the workflow process were presented.

This paper does not include the definition of a business process, because it does not differ from the generally accepted definition. One of the examples of difficulty in translation can be the basic concept, i.e. “workflow”, which does not have a direct Polish translation. The Polish version of the definition concerning the concept of workflow (mainly translated into Polish as “przepływ pracy”), taken from the glossary of WfMC and given by Z. Martyniaka [MART00] is as follows: “The automation of business process, in whole or in part, during which the documents, information and tasks are transferred from one participant to others for the purposes of implementation of an action pursuant to the set of formalised rules”. This term is the source of the definition of workflow system usually translated as “system przepływu pracy”. The definition reads as follows: “The workflow system is a system which, on the basis of a software, allows for creating definitions of processes and managing the implementation of instances of processes launched on one or many workflow engines which can interpret definitions of processes, communicate with the participants of the workflow and, where it is necessary, it can trigger other applications” [ĆWIK06, MART00]. The ability to manage the business process implemented in the organisation in accordance with the previously defined, prepared or configured definition of process is a very significant and characteristic element of the workflow IT system. It was also noted that, in accordance with the general concept of workflow, it refers to the “transportation” of documents, information or tasks between the participants of the process, i.e. the organisational units or particular persons who belong to the organisational structure.

Following the explanation of the workflow system, the definition of the workflow process was quoted: “(...) it is a form of business process presentation allowing for automated processing such as modelling or implementing a process by a workflow management system” [RENK12]. The definition of the process consists of a network of activities and relations between them, criteria for initiating and completing the process and information on particular activities such as performers of the activity or applications and data related to the activities.

2. General assumptions of the proposed methodology of workflow processes analysis

The analytical methodology proposed by the author derives a bit from all the most important approaches to IS analysis and design. The main analytical perspectives of the methodology are consistent with the structural approach. Ac-

cording to it, the complete analysis of information system requires the description of **data** processed in it and **processes** within which this processing takes place [YOUR89]. However, it was pointed out that the processes would be described in more complete, business terms, not just in purely informative terms (which constitutea difference in comparison to the structural approach). The additional perspective used in the proposed methodology are activities. To increase the accuracy of the workflow model, the methodology proposesa description of each activity specified in the process model on the lowest level, i.e. the scenario of its realization. As it was stated in the introduction, the process and data model, scenarios of activities or states do not exhaust the subject with respect to the workflow system. In this case the perspectives should be broaden and some of them modified.

The workflow system is a specific type of information system in which the information, documents and tasks are transferred between the participants in accordance with the set of formalised rules. The economic organisation consists of participants who are divided into organisational units and work in the functional reporting system – within the organisational structure. It constitutes the frame which indicates which organisational unit or position has the duty and authority to collect information, perform the task or process the document. That perspective was called the organisational structure.

Modern business organisations have a very wide territorial scope of activity which very often has impact on multi-department, regional or global structures. Often the companies create joint holding groups which may use common IT tools. This context is also significant for the workflow system where the dedication of tasks must include the geographical region where a particular organisational unit or position is located. Such an analytical perspective was called a localisation structure.

The set of formalised rules of task, document and information flow is a very significant element of workflow. It is the key control element for this type of systems. The business rules are taken into account in majority of approaches to IS analysis and design. However, in other categories of systems, the modelling of rules is focused on the presentation of the algorithm for calculating certain variables and, to a much lesser extent, on the presentation of control in processes. The second aspect is the key aspect in the workflow system and must include the conditions of navigation within the organisational and localisation structure.

Another analytical perspective proposed in the methodology is the enterprise concepts structure. The conceptual aspect is taken into account in classical methodologies within the data model presenting objects, attributes and relations which the organisation wants to know about. However, this attribute level is not sufficient for the workflow, because it is not enough to indicate that the object attribute concerning the employee at the organisation is their position; it has to be described which competences are assigned to each position and what are the mutual relations between the positions (this is a reference to a particular organisational structure). The data model does not include the formal templates of documents, forms or other templates prepared in the organisation. The workflow system is a flow of data sets which physically has the form of formal documents consistent with the established and described templates. Description of these templates, as well as abbreviations and references used in them, are based on the concepts specifically defined in the life of an organisation – in this paper they were called enterprise concepts.

To model the workflow system completely, with taking into account the above-mentioned conclusions, the proposed methodology has to indicate the following four additional perspectives:

- organisational structure,
- localisation structure,
- business rules,
- enterprise concepts.

In further part of the paper the proposed methodology will be referred to as the abbreviation SPARD (from the first letters of the English names of the main perspectives). Particular analytical tools were chosen for the indicated set of perspectives; their full list is presented in Table 1.

Table 1
Perspectives and tools of SPARD methodology

Perspective	Tools
Organizational Structure	Org Chart (OC)
Localisation structure	Localisation Chart (LC) (on the basis of UML deployment diagram)
Processes	Business Process Diagram (BPD) (consistent with BPMN)
Activities	Use-case scenario
Business Rules	Pseudocode
Data and enterprise concepts structure	Data and concepts dictionary (DCD) Entity Relationship Diagram (ERD)

Source: Own elaboration.

The analytical tools used in SPARD methodology are derived from various approaches to the information systems analysis. The organisational structure diagram is not related to any IT approach; it is used in the management and economic methods. The notation of the deployment diagram constituting the component of UML [FOWL2003]. The BPMN used for process modelling is currently the most popular tool used in the process-based approach [DREJ11]. The use-cases in the object-oriented approach are the basic tool for the specification of requirements concerning the system [COCK00]. The scenario is a text tool, however it is properly formalised and unambiguous. The pseudocode, data dictionaries and Entity Relationship Diagram ERD are known and are used in the structural approach [YOUR89].

3. Specific workflow perspectives and analytical tools

Perspective of the organisational structure perspective – diagrams of organisational structures

Presently, the organisational structure modelling is not included in any of the main approaches to the analysis of information systems (the organisation – OMG, involved in the development of the object-oriented standards, works on the presentation of the organisational structure and its implementation in further versions of UML – www.omg.org [ŻELE12]). In the workflow systems the responsibility for assigned tasks and competences for their performance comes directly from the organisational structure. The org chart (OC) will be used for modelling this perspective. The org chart presents the division of the organisation into organisational units (business units) and positions with their reporting relations. Usually the organisational units consist of groups of employees. In case of individual employees there are positions. For the purposes of the workflow systems modelling the term of a role was proposed in place of a position. The role indicates the ability and authority to perform an activity, for example, project manager, warehouse operative, administrator. Figure 1 presents an illustrative diagram of the organisational structure.

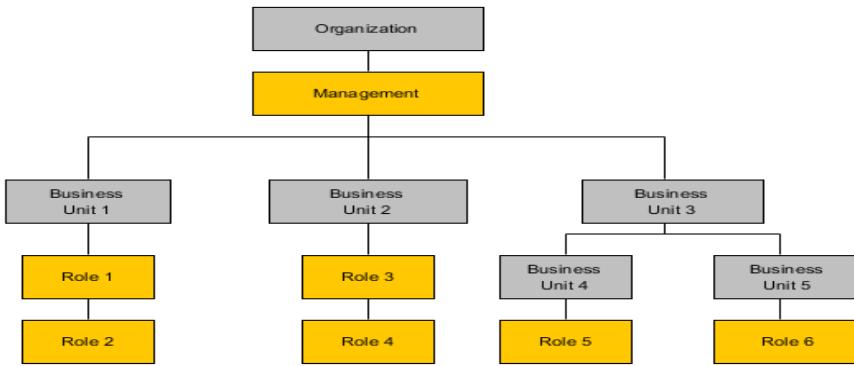


Fig. 1. Illustrative diagram of the organisational structure

Source: Own elaboration.

Perspective of the localisation structure

– diagrams of the localisation structure

To illustrate the physical structure of the organisation the notation of the deployment diagram constituting the component of UML was proposed. The symbol of a node in SPARD methodology stands for a physical, geographically separate localisation within which the activity of the modelled organisation is conducted. To obtain a more complete picture, the organisational units operating in a particular localisation are described. The directional relations between nodes (localisations) can be marked, however, in majority of cases these relations are bidirectional. The additional element shown in the localisation chart is the system equipment of particular localisations. Figure 2 presents an illustrative diagram of the localisation structure.

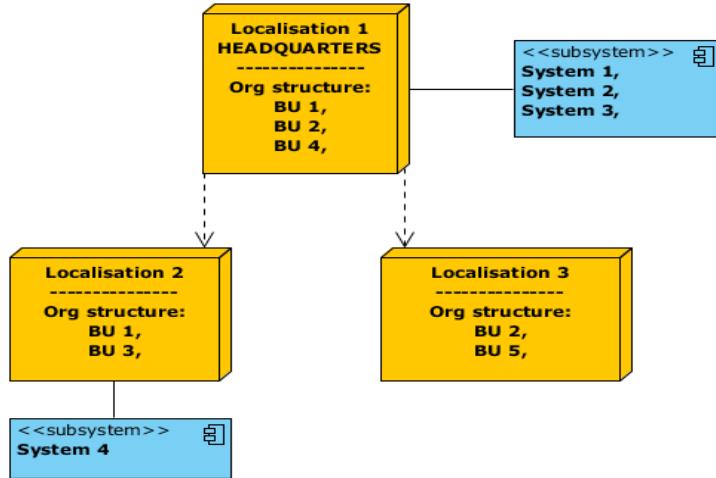


Fig. 2. Illustrative diagram of the localisation structure

Source: Own elaboration.

Perspective of business rules – pseudocode

With regard to the description of business rules, a very important task is to create an accurate, formal and algorithm representation. While creating a workflow model it has to be noted that the rule has to be encrypted in the code of an IT tool operating the workflow, particularly in the definition of the workflow process. The business rules in organisations are usually kept in form of regulations or instructions. During selection the tool for modelling the rules of the proposed SPARD methodology, the representation matching the requirements of the formal algorithm and comprehensibility of the business language was searched for. The pseudocode was chosen, otherwise known as the structural Polish language, a process specification method known from the structural approach (OCL, known from the object-oriented approach, was considered less accessible). On the one side the pseudocode is structural, i.e. it should include sentences with syntax which resembles the code of program instructions, i.e. the instruction and parameters of its triggering. On the other side it is the Polish language, because all the instructions and parameters will be included in the specification of the rule in the Polish language [YOUR89].

Three main rules of the pseudocode:

- the pseudocode instructions are verbs in the Polish language,
- the instruction parameters may only be the elements of data related to the described model, i.e. the ones included in the data and enterprise concepts dictionary,
- within the pseudocode there is the possibility to apply conditional functions describing the alternative action after fulfilment of appropriate conditions (for example if-then, case or do-while).

Example of the business rule specification with the use of pseudocode:

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if faktura_kwota_brutto >= 50 000    then akceptacja [Prezes_zarządu]
                                         else akceptacja [Główny_księgowy]
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where (faktura_kwota_brutto – is described in the data and enterprise concepts dictionary, and Prezes_zarządu, Główny_księgowy – are the roles additionally described in the organisational structure).

Perspective of the enterprise concepts

- data and enterprise concepts dictionary

The data dictionary specified all data object elements used in the workflow processes. The data dictionary is a text tool, however, it is formalised. The data elements are taken from data objects in org charts, localisation charts, BPD, ERD and descriptions of business rules. The dictionary should also include definitions of enterprise concepts which are present in the specific communication language of the organisation.

The data dictionary includes three types of elements:

- elementary data – data which is not subject to further division,
- data packages – elementary data set,
- enterprise concepts.

All above-mentioned types of elements are described within the category of context, definition (for the packages), unit of measure and limit values (for elementary data). The naming convention shown above comes from the Yourdon Structured Method [YOUR89] (except for the enterprise concepts which were added by the author). An example of the data dictionary is presented in the next chapter.

4. Practical example of use of the specific workflow perspectives

General characteristic of the analysed organisation

The object of a sample scenario will be the company KPRM – Krakowskie Przedsiębiorstwo Robót Mostowych. This enterprise specialises in the construction of bridges and hydrotechnical structures. KPRM provides comprehensive investment services, starting from the design phase and ending with execution and operational supervision. The seat (headquarters) of the company is located in Cracow. The company is a multi-department organisation with three area branches. Each branch has its own resources and implementing measures. In the headquarters of the company a dozen building contracts are simultaneously carried out. The branches manage a few building contracts at the same time.

KPRM is preparing to implement the workflow system which will allow for the realisation of the new controlling policy of the company. The basic assumption of the new controlling policy is the possibility of an ongoing monitoring of the financial results of the company with details concerning individual contracts. Persons appointed by the Management Board are to be responsible for the results of particular contracts and results of organisational departments working to the benefit of the contracts. With regard to the above-mentioned assumption, majority of operation should have a several-stage authorisation. Presently, the basic information problem of KPRM is the flow and registration of expenditure documents, particularly external documents and those which are sent directly to the area branches of the company. The flow of documents in its current approach, based on the paper carriers, is very time-consuming, requires double amount of labour and generates many errors. As a result, the financial results are known only during the tax return period (20th day of the next month). The discussed example will provide only the analysis of the process of purchasing documents flow – a significant, but not the only process that needs to be optimised at KPRM to implement the new controlling policy effectively.

Cycle of the workflow process analysis concerning the purchasing operation

a. Analysis of the organisational and localisation structure

The first stage was the analysis of the organisational structure as the frame of the workflow processes. The starting point was the “official”, documented organisational structure. It was the basis for the system of organisational units, whereas the positions were mapped into roles significant for the workflow system. Creation of OC was not completed at the end of this stage and there were

situations during the process modelling when additional roles were found. Figure 3 presents the fragment of OC for the company KPRM. Next, the diagram of localisation structure was created (Figure 4).

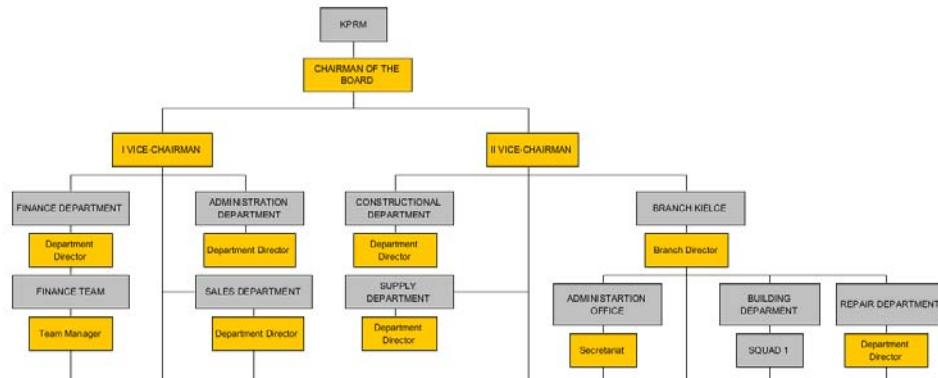


Fig. 3. Fragment of the organisational structure diagram of KPRM

Source: Own elaboration.

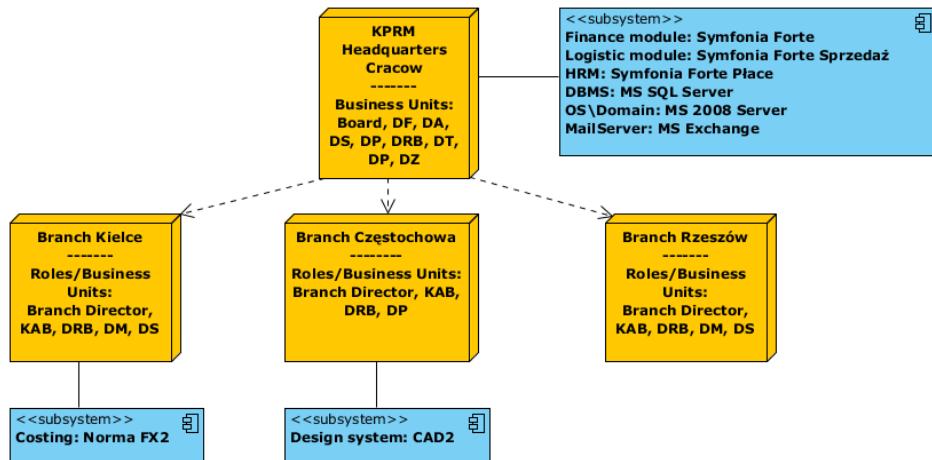


Fig. 4. Localisation structure diagram of KPRM

Source: Own elaboration.

The creation of the data and enterprise concepts dictionary was commenced already at this stage.

b. Workflow process analysis concerning the purchasing operation

The next step was the analysis of purchasing operation process with regard to the roles and the sequence of activities. BPD was created. The model of processes can be changed and modified many times, because during the analysis of scenarios of particular activities or the business rules, the analysis team comes up with new “ideas” and adjustments to the described processes. Figure 5 presents the fragment of BPD for the workflow process concerning the purchasing operation.

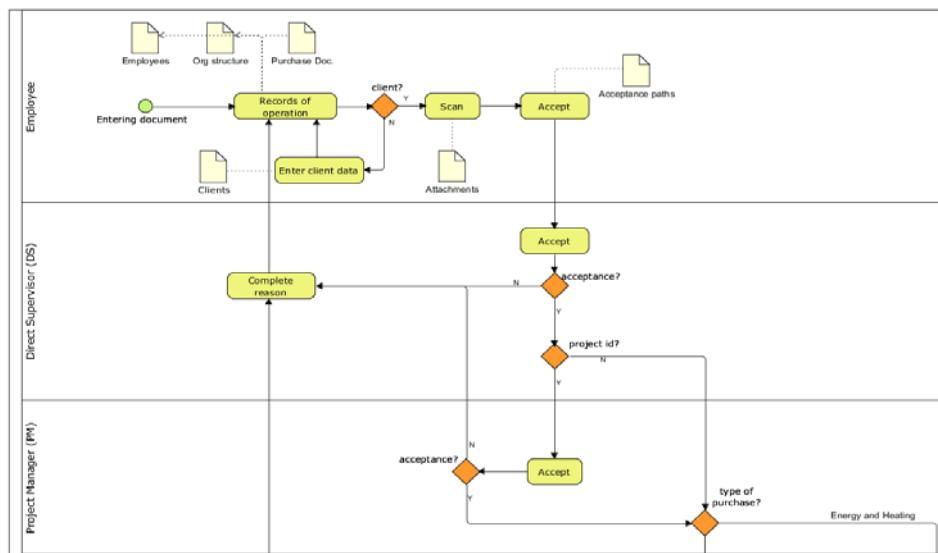


Fig. 5. Fragment of BPD concerning the purchasing operation workflow
Source: Own elaboration.

c. Analysis of business rules

Together with the process model the business rules controlling its course were described. Simple rules were described directly on the diagram, just like in the case above. The more complex ones were described separately. In the last case the rules of pseudocode were applied. The rules for the analysed workflow process concerning the purchasing operation were collected in the table presenting the process path depending on the type of purchase (Table 2). With regard to the large size of the table, the rules of acceptance were shown only up to the

third level and only three types of operations were included; the source process handled nine types of acceptance levels and had five acceptance levels.

Table 2
Rules of acceptance paths depending on the type of purchase (fragment)

Acceptance levels Types of opera- tions	Level 0		Level I		Level II		Level III	
	Role	When	Role	When	Role	When	Role	
Primary and secondary materials	Employee	Always	Direct Supervisor (DS)	? Project id	Project Manager (PM)	Always	PD	
Stationery	Employee	Always	DS	Always	Purchase department (PD)	dok_zak_kwota_brutto >2 000 PLN	Chairman	
Energy and heating	Employee	Always	DS	? kontrakt	PM	dok_zak_kwota_brutto >2 000 PLN	I Vice-chairman	

Source: Own elaboration.

d. Activities and data analysis

Further stage of the analysis was to divide the activities shown in the process model into steps which needs to be taken by the role or system. Due to the volume of the paper and described scenarios they will not be presented. Simultaneously with the description of scenarios of particular activities, the data and enterprise concepts dictionary was developed. Table 3 presents the fragment of the data and enterprise concepts dictionary.

Table 3
Fragment of the data and enterprise dictionary

Data/concept	Context	Definition	Limits	Unit of measure
dok_zak_data_sprzedaży	Sale date appearing on the document			Date (dd-mm-yy)
dok_zak_termin_platności	Maturity		0-365	Integer (4,0)
dokument_zakupu	External or internal document showing the operation of the purchase made by the KPRM	dok_zak_numer + symbol_klienta+ +dok_zak_data_sprzedaży +dok_zak_data_wphwu + numer_pracownika + symbol_dzialu + {dok_zak_opis_pozycji +dok_zak_kwota_netto+dok_zak_stawka+ numer_kontraktu}		
Project manager (PM)	An employee designated by the Board to oversee the contract. Responsibilities is describe in Attach xx.			

Source: Own elaboration.

The data and enterprise concepts dictionary does not exhaust the subject of the data model. Upon describing particular objects, the relations between them were modelled. ERD, due to the volume of this paper, will not be presented. The methodology itself and more detailed description of the case are the subject of the author's next paper.

Summary

The significance of such specific analytical perspectives of the workflow system as the organisational and localisation structure, enterprise rules and concepts, was proved practically. Basically throughout the entire period of modelling, the analysis team was referring to diagrams or specifications of these perspectives. It can be stated that the organisational and localisation structure constitutes some kind of a frame and a mechanism for testing the completeness of the model. The model, created in accordance with SPARD methodology, may be the starting point for collecting requirements concerning a new IT tool supporting the workflow, as well as for the commencement of the simulation process analyses, description of ISO procedures or developing the expenditure and controlling policy of the company.

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SPECYFICZNE PERSPEKTYWY ANALITYCZNE W MODELOWANIU SYSTEMÓW WORKFLOW

Streszczenie

Systemy informatyczne typu workflow stają się coraz popularniejszymi narzędziami IT warstwy oprogramowania aplikacyjnego przedsiębiorstw. Aby zapewnić skuteczność wdrożenia systemu workflow w przedsiębiorstwie, powinna go poprzedzać gruntowna analiza biznesowa i uporządkowanie oraz niejednokrotnie reorganizacja procesów. Teoria analiz i projektowania systemów informacyjnych dostarcza wielu metodyk i narzędzi analitycznych, jednak istnieją perspektywy ważne dla systemów workflow, które nie są w nich wystarczająco uwzględniane. W artykule wskazano na perspektywy struktury organizacyjnej, struktury lokalizacyjnej, reguł i pojęć firmowych jako elementy konieczne do pełnego modelu procesów workflow. Celem jest wskazanie roli tych perspektyw oraz narzędzi analitycznych potrzebnych do zbudowania kompletnego modelu systemu workflow. Ostatnia część artykułu pokazuje praktyczne zastosowanie wskazanych narzędzi w rzeczywistym przypadku analizy przedwdrożeniowej.