

Time Factor in spatial description of business processes execution

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Abstract—The article was devoted to the issues of the time factor in the framework of descriptions of business processes. In the considerations spatial description was proposed to describe the business processes models and its execution. It involves the use of GIS technology. In the article, the time factor has been treated in five contexts: as a measure of the length of time to develop new sources of revenue, implementation of new or modified process models, the element description of the operation carried out in the framework of processes, defining element of performance indicators and a factor contributing to the search for new lines of business. The proposed concept is based on the extended description of the business process models covering the algorithm process, actors, documentation, resources and efficiency ratios. It assumes that the execution of each operation under the implemented processes must be described in a computer system. Thanks to the integration of different types of information systems implemented processes can be visualized in tools such as Maps of Enterprises and Maps of Processes

Keywords—Business Process Execution, GIS, Maps of Enterprises, Maps of Processes, Spatial description Time factor.

I. INTRODUCTION

THE PROCESS approach is becoming increasingly popular solution used by modern managers [1]. It seems that on one hand it can more effectively mitigate the effects of changes occurring in the turbulent business environment, and on the other one, relatively easily can be described in ubiquitous systems.

Computer systems have become an essential tool to support the functioning of the organization and implementation of various economic projects implemented by many actors [2] or [3]. All stakeholders should have the opportunity to inspect the description of the state of completion of individual processes. They take note that many organizations are involved in different processes at the same time. Tools enabling on one hand to track all processes, and on the other hand making it possible to track the status of use of particular types of resources available in the organization (about Business Process Modeling [4], [5]).

In these considerations it was proposed to use spatial tools, based on GIS methodology (methodology of Geographic Information System – [5]) to build maps of organization (MoO) and maps of processes (MoP). These maps allows to

make a spatial description (SD) of selected aspects of the state of the organization and its various types of resources and implemented in its processes. The article discussed the issues presented from the viewpoint of the time factor. Therefore, the time will be the main topic of the presented issues [7].

The article shows how to use spatial description of selected aspects of the organization, taking into account the time factor. The main emphasis is put on the issue of the organization of the proposed tool with regard to analysis of its possible applications. the efficiency of the individual organizational units. document is a template for Word (doc) versions. If you are reading a paper version of this document, so you can use it to prepare your manuscript.

II. NEED OF DESCRIPTION OF BUSINESS PROCESSES

Implementation of information systems for companies prevailed the target of arrangement of implemented processes. In those days (years 60 - 80th of the last century), the primary aim of the organization was to build production lines to enable mass production. The aim of the systems was to collect data on manufacturing activity performed and rational planning of production processes (standard MRP - Material Requirement Planning and MRP II - Manufacturing Resources Planning). These standards then transformed into contemporary ERP / ERP II (Enterprise Resources Planning) [8].

With the use of computer systems information needs of their users were increasing. Moreover, these systems have an impact on the transformation of the modern economy, and also on their basis new communication media based on WAN technology - Wide Area Network, and nowadays mainly using the Internet and Web Technology were created [9].

To create systems special technologies to support their modeling were developed. Initially, these were the CASE Tools (Computer Aided Software Engineering Tools). They support the process of building systems, including modeling of information processes. Information processes so that they can serve not only the primary events in the organization, but also will enable the various types of analyzes of economic, financial or study of the effectiveness of the individual organizational units. Such information processes related to higher functions such as reporting, automatic analysis and control, planning and supporting or decision-making processes [10].

With the spread and improvement of tools for modeling systems, a need to consider whether these tools can not be

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used directly for modeling business processes appeared. At the turn of the century a variety of tools for modeling business processes, such as, among others, AD UML (Unified Modeling Language Activity Diagram) – [11] and BPMN (Business Process Model and Notation) - began to appear [12]. Thanks to them, building algorithms of business processes is no longer a problem. Moreover, modern tools allow for dynamic matching processes to the needs of the present and the analysis of conflicts between different versions of the same process [13].

Business process models stored in a strictly formal notation can be used in two ways. First, use them to create enterprise rules. Second, stored procedures can be converted to the functions of information systems and structure databases. This can relatively quickly build business procedures, test their effectiveness and adjust them to the requirements of turbulent environment and available resources.

The use of process management in enterprises facilitates the search for new sources of revenue. As a result, instead of activities in high-volume production figures can be used processes tailored to individual customer needs. The problem is that it is much harder to analyze many diverse processes carried out at the same time. This should include the examination of the effectiveness of individual processes, their fragments, waste of resources, involvement of actors or analysis of existing conflicts, untapped resources, bottlenecks, etc [14].

A growing challenge for managing processes becomes overseeing the implementation of the current processes. There are many tools (eg. The Class BI - Business Intelligence), but mainly they are intended to present synthetic data [15]. Meanwhile, for management efficiency useful becomes data on the implementation of ongoing operations. It is especially important for integrators of processes who are responsible for Business Processes Execution [16].

The application of business models to create corporate regulations are intended to identify employees ways of implementing individual operations, while also point to the rules of their marks for the tasks performed. It is a kind of knowledge management in an enterprises [17]. However, in order to meet the projected models of its objectives certain conditions must be met. These include :

- the use of process modeling tools business compatible with the applicable systems,
- the use of extended description of processes,
- the need to build a dictionary of corporate,
- adequate training for integrators processes and their contractors.

From the point of view of the enterprise, business process models have their principal use in the implementation phase processes [18]. Then they serve to describe the ongoing operations, controlling the state of implementation and allow a variety of analysis (provided of course that has been made an extended description of the process).

III. TIME FACTOR IN BUSINESS PROCESSES

Time is one of the important factors affecting the performance of the enterprise or economic agreements. As part of the issues discussed, the following contexts relating to the time factor seem to be important:

- 1) The length of time as a measure to develop or improve creating new sources of revenue or designing new business models
- 2) Time as a measure of the length of implementation of individual operations within specific processes
- 3) Time as a description of operations performed
- 4) Time as a measure of the effectiveness of implementation of individual operations or the whole process
- 5) Time as a stimulus to create new processes

For the development of each company it is important to search for more and more new sources of revenue. Time can be regarded as a simple parameter for estimating the rate of acquiring new sources of revenue. For example, it is possible to specify the number of potential sources of revenue developed or implemented and new types of business processes being realized. Time can also be used to construct composite indicators. It is possible, for example, to estimate the value of revenues from new types of processes used within a specified period of time (eg. in the framework of the types of processes implemented in the last 12 months).

The second context determines the length of the implementation of different types of processes. First, the length of designing the model and then the length of the work to adapt the type of process in the company. The mentioned parameter is to determine how long it takes to transform the proposed sources of income in real activity. This parameter can also be used to measure the time, how long it takes the company to adapt to the specific needs of customers. This parameter is important as it determines the capacity of the enterprise to adapt to individual customers. It can also affect the structure of loyalty systems being built.

The execution of each operation under the currently ongoing processes should be immediately recorded in the computer system of the company. One of the main features describing the event is an indication of the time of its occurrence. In this case, the event is usually understood as the execution of the following operations under the process.

The requirement of registration of execution time for each event enables testing the efficiency of operations and the entire processes. This can include evaluation of the effectiveness of the work performed by actors carrying out the process and on this basis to build an incentive system. The feasibility of the project assumptions included in the process model to the practice of their implementation can be analyzed. It also allows ongoing monitoring of the current state of the process [19], [20].

Collected data on the duration of the individual processes can become inspiration for managers and integrators of processes. Their task is to estimate the time of raising the necessary resources. The results should indicate whether the

time necessary for execution is a competitive advantage to the company or if it is not its weakness. This in turn can lead, among others, to seeking shorter routes of implementing processes, or to expanding the own network in order to cover a larger area of influence. In this way logistics strings may be shortened, and by the way, this should reduce costs for necessary logistics services.

IV. EXTENDED DESCRIPTION OF BUSINESS PROCESS MODELS

From the point of view of actions of a company, the most important is building algorithms of the modeled processes. However, for information service, analysis and monitoring needs as well as conducting rational management of available resources of this type, descriptions are insufficient. To handle the mentioned issues, extended description of the proposed process models is postulated. It contains the following elements [21]:

- 1) The algorithm of the process,
- 2) Actors,
- 3) Created documentation,
- 4) Identification of all the types of resources necessary for performance of the process,
- 5) Indicators of the efficiency of processes, fragments of processes and operations.

Modeling of an algorithm of the process creates an outline of organizational procedures. It specifies how to implement business processes. It should be assumed that the designer has developed a process in such a way that it is implemented as efficiently as possible. Algorithms can be developed using tools like UML AD and BPMN. The use of appropriate tools to describe algorithms allows to convert prepared descriptions of the models on the procedure system. Process maps themselves usually constitute the element of corporate instruction.

Roles of actors can be applied on algorithms of processes. For this purpose, DFC (Deployment FlowCharting) can be used, for example. This way, actors at any level of detail (specific employees, organizational units, branch offices, outsourcing, subcontractors, etc.) can be identified.

In the development of process models semantic order of the organization should be maintained. Actors marked in the DFC should be agreed with the list of OC (Organizational Chart) or a dictionary of partners (cooperating entities). OC may be extended to employees who work with the company in various ways [22]. These may be other firms (single subcontracting, outsourcing) or workers on one-off task, or cooperating more or less closely. Developed liability must reflect all stakeholders, including external, taking into account current trends in the functioning of enterprises, such as: virtualization, organizations and processes, variability borders and other organizations.

The third element of the description is documentation reflecting the state of implementation of processes. At the modeling stage, it is determined what type of documents should be created as a result of implementation, or the specific

effects of the operation and what information fields should be filled. This is also important in order to convert a business process model for IT system procedures describing the process. At the stage of the registration process it is carried out using appropriate information systems, eg. ERP or AOT (Automatic Offices Tools), integrated with tools ICT (in particular internet solutions) – [2].

The fourth element is a description of the resources. The task is multi-stage. The starting point is to develop a classification of resources within the organization. It is important that developed classification is sufficiently detailed and was reflected in the corporate dictionary and terminology used in information systems. Therefore, a type of index, and on the basis of dictionary resources is created. This allows to describe those resources in information systems (mostly ERP, but also include GIS or CAD - Computer Aided Design). This allows to define resource needs, inventory owned and their allocation within the accepted rules. With the classification of resources and leading their records, they can be assigned to specific operations within the modeled processes. These actions constitute expanding the scope of the Technological Cards in Production module of the ERP. This can then record the use and the flow of resources during the implementation process. Data collected during the implementation process can then be used for analytical monitoring and support planning activities.

The fifth element is the indicators of performance. With it, it is possible to define potential requirements for the planned processes and their operation and to evaluate the completed processes. To develop indicators of performance it is necessary to develop the rules for estimating, calculating, or recognition of the states. For this purpose, corporate dictionaries should be used, where individual terms and conditions should be defined. Basing on definitions of indicators and collected data on the implementation of processes, assessments of the use of particular types of resources, organization and evaluation of individual actors can be defined. The results can also be used to modify process models and the introduction of different types of organizational changes.

Expanded description of the modeling decision-making processes is important not only for managers to build corporate governance. These descriptions are also necessary for the implementation of individual processes. The actors have defined rules of conduct, they know the rules of self-assessment activities, and information systems are equipped to handle specified types of business processes.

Using information systems for the registration of each operation taking place in the context of processes on a regular basis, it can be, among others, : status of implementation of the process, the actor-executor of the operation, duration of the operation, resources involved and verify compliance of the implementation of operations with the established performance indicators.

The data collected allows to make various analyzes which

could include the number of performed processes in a given unit of time, the number of operations carried out by different actors in a given period, the volume of waste or used resources, the effectiveness of ongoing operations and the like. The individual analysis can be made for any unit of time. As it can be seen, time becomes an important indicator influencing the rationalization of the operation of enterprises.

V. ASSUMPTION OF SPATIAL DESCRIPTION

The spatial description rests on visualization of business processes with the use of GIS technology [23]. GIS Technology was founded as a result of the use of information systems in cartography. However, it soon became clear that GIS technology can be used not only for geographical areas [24]. There are also applications of this technology including in astronomy (sky map), medicine (anatomical maps), and also more and more often they are used in various other areas of life.

The cartographic methodology over a long period of time was associated with the technology of building maps. Mainly maps were printed on paper and the content contained in them was unchanged. The use of GIS technology allowed using animation techniques [25]. Making maps built in the GIS technology can show the dynamics of the phenomena if the relevant data will be delivered. Integration of GIS with other types of systems (eg. ERP and CRM) allows to connect relevant databases [26]. In this case, the descriptions of operations having attributes periods may be able to visualize phenomena using animation technology. The time factor is in this case essential element of visualization of the processes.

The space description of business processes can be implemented in different ways. The basic methods include:

- geographical maps used for management,
- maps of enterprises (MoE),
- maps of processes (MoP).

Maps used for management purposes are mere electronic maps. Their specificity lies in the selection of appropriate layers (L) that visualize the selected class of objects C(O) selected by the user in the system. Modern GIS tools enable the user to turn on or off layers as needed. Thanks to this, on the map may be only data of interest of the user, and the rest can be turned off in order not to destroy legibility of the map.

Normal maps can be both static and visualize selected issues as of the indicated time and be dynamic and capable of visualization for a selected period, present the implementation of selected processes, and even impose selection processes at each other, they can also simulate the future appropriate data forecasting data will be developed. Data visualization can come both from the given company, and from the environment. From the environment come general geographic data and descriptions of phenomena and processes carried out outside the company. On these layers can be applied thematic layers based on data collected within the company (eg. in their information systems including ERP, CRM, CAD/CAM) [27].

These maps may be available in the desktop version, by

webservices or in various types of devices such as, among others, GPS (Global Positioning System). In most presented applications they can be link together internal and external data. Using the mentioned types of maps, including determining the territorial scope of the impact of the company, setting directions for expansion, looking for sites for the location of new branches, checking the absorption of the market. These maps can also be used for logistics in the context of the processes (eg., to determine transport routes, transport control, and even search for parts of routes in case of emergencies) [28].

Maps enterprises (MoE) can be developed for different types of space [16]. They can be both geographical spaces, as well as heuristic or mathematical. Geographical spaces are typically used for companies with extensive spatial structure. Then on geographical maps can be applied to the location of their organizational units or business partners. In other cases, it used mainly mathematical space, which is applied to the OC. But first it is needed to develop rules for the location of individual organizational units on the map. It is understood that the location is carried out by making all local spatial attributes (AS). These attributes should be permanent, so it will be easy to find on the map can be individual entities, organizational units, individual employees, and even co-operating entities.

On the MoE it is possible to try appending individual entities owned /available resources in them. In this way, it can be indicated which units may be involved in specific projects. In fact, maps are static, unless the company is growing and is in the process of building their own spatial structure. More dynamic maps can visualize the status of various types of resources. The flow of resources between different organizational units is typically faster than changes in the organizational structure.

Maps of processes (MoP) are intended to visualize the progress of the individual processes. They have their static and dynamic version. The static version of the algorithm describes the course of the process between the designated actors. In this version the actor may be an organizational unit or a set of cooperating entities.

The dynamic version of MoP is used to describe processes. An important condition is to have relevant data describing the current status of the individual processes. That description should be in the database systems used in the company, mainly in ERP. With the integration of ERP with GIS it is possible to visualize the current status of all indicated processes simultaneously [29].

MoP may also be used for planning for the execution of the current running processes. It is mainly among others to identify implementers running or planned processes or booking resources needed for a limited time.

Basing on data from business processes it is also possible to prepare different types of analysis and control maps, which will be show all the positive and negative phenomena. This is a reference to performance indicators. Data describing the

technology, the processes will be verified by the formula defined on the basis of performance indicators. The results of inspections will be developed and visualized automatically, based on the data collected. One important factor that will be used to measure the effectiveness of the implementation of individual processes will be time.

Technology of spatial description itself will be based on the following elements:

- 1) Space - S
- 2) Cartographic grid - G
- 3) Classes of object - C(O)
- 4) Spatial attributes of individual objects - A_S
- 5) The attributes that describe the objects - A_D
- 6) The principles of symbolization of objects on the map
- 7) Data sources

It is worth to point out that spatial visualization can be used with hipertext. Thanks to it directly from the map it will be possible to receive an additional description of the presented objects.

VI. APPLICATION OF THE TIME FACTOR

Implementation of business processes should take place according to algorithms developed in a model. Even after selecting the actors in the model it is not clear who will be the direct executor of the process and at what time will immediately proceed. Considering that in contemporary reality there is usually a buyers' market, executor of the process should make every effort to meet the needs of the customer. Very often one of the indicators of quality for the customer is the speed of the process. This could apply both to the processes already designed and completely new potential sources of revenue.

New business opportunities looming on the horizons should be quickly detected and verified for economic and organizational links. Therefore, it seems that due to the time factor, it is worthwhile to develop process models, not only for the immediate production processes, but also for the supporting processes. The use of this methodology should be the occasion to facilitate the creation and implementation of appropriate modules information system that will facilitate analysis of the emerging new sources of revenue. This will also treat the design stage business models as a normal business process with all the consequences resulting from this fact.

The time factor is also important when modifying existing business models. Although work is underway on the issues of dynamic business process modeling, but the main focus is on comparing and matching the next version of the model. Mainly it analyzed the algorithm of the process. Taking into account the time factor should favor the current verification models, and also will describe existing conditions so that in the future this will facilitate the integrator choose the right version of the model, depending on prevailing market conditions and requirements of the customer.

. The space description is mainly used to visualize the

current state of the enterprise. Using different attributes that describe the objects, the status of the company at a different angle can be viewed. Such as, among others, utilization rates of production capacity and other resources per unit of time, the analysis of bottlenecks, the distribution of jobs between different actors and others. Many of the analyzes carried out on the basis of spatial visualization are based on the use of the time factor, particularly those which use animation techniques.

Implementation of new business models can be considered as organizational innovations. The time factor is important in two stages. The first is the mere implementation of new models and the other is preparing the implementation of a specific process.

The first stage consists of verifying the developed model. Then, the conversion of the developed record of a model for procedures of information system and dictionary and corporate regulations are verified.

Just as in the tools of design of information systems, so the developed models must be internally consistent and must agree with dictionaries and corporate rules. System of operations, actors, documentation, classification of resources and the settling efficiency formulas must be described in a computer system. Only then should the model be allocated for use.

Corporate Dictionaries can also be written out with the help of spatial description. In this case, the corporate dictionary can be scored for the heuristic space. The mentioned space may be 2- or 3-dimensional and there all the concepts can be checked out, combining them with appropriate relationships with others [30]. In turn, corporate regulations can transcribe the schemes and also visualize them in the heuristic spaces. Such solutions are used mainly by applying AOT class systems and making them available to all interested users.

Taking into account the time factor, in this case, business models that to a minimum speed up implementation of new models can be developed.

Defined in the system process models can be used for specific business activities. However, it is not sufficient to start the specific process. The task integrators include defining the conditions for realization of the process (where the time may be an important factor - eg. the process can be designated for an absolute dead line, which can not be exceeded), indication of specific actors and assign specially selected resources. In this case, it is important reservation of such stocks, which will be achieved with adequate visualization plan for their use. Said spatial visualization will be possible thanks to the typing for ERP about scheduled processes for implementation. In the present visualization of the time factor it will be used as a constraint for the allocation of new tasks due to a lack of available players or resources. For this purpose MoE may be used.

Each document should have a corporate indication of the date of its preparation. Generally, the problem is solved by information systems, because all records are recorded with the designation of time. Due to the fact that each operation should be completed in the relevant document stating its effects

currently, it is possible to track the status of implementation of the specific process. Using space description, the status of implementation of many processes simultaneously can be visualized, while states will be regularly updated, which will be seen on MoP. An additional advantage of spatial visualization is the ability to change the criterion of presentation so that it is possible to present the processes and participating actors from different points of view. Implementation of the mentioned visualization is made possible by the integration of ERP systems and GIS. ERP provides data from databases or DocumentBases (DocB) and GIS visualizes them.

Time in these presentations plays an important role. First of all, it determines the order and the moment when additional operations are performed. At the same time, it allows for the definition and calculation of the scope of activities of individual actors, their involvement in the processes in a given unit of time, to estimate the volume of waste resources and make many other types of analysis. Nowadays, such tasks are carried out by BI (Business Intelligence), and in particular their Cocpit Manager module. BI is treated as a part of the ERP or expand it to allow the use of higher function information. The space description can on one hand be regarded as competition for Manager Cocpit, while on the other hand, as their development.

The use of the extended descriptions of business process models with regard to performance indicators allows to use the time factor to the current state analysis of the processes. The use of spatial description lets users visualize the processes being performed. Using the appropriate symbolization (based on cartographic symbology) can be properly classified operation for each subsequent operation in all processes at the same time. For integrators it is a tool to control the work of subordinate actors, while for managers it is a tool to assess both employees and processes integrators.

As an indicator of effectiveness in this visualization, time will have a double meaning. On one hand, it allows for ongoing assessment of the ongoing operations of many (in many of them performance indicators that were used will be based on time - eg. the duration of the operation, the percentage of time of the operation within the whole process, etc.).

These indicators may be defined in the selected modules either ERP or at the BI level. The evaluation results are given on a regular basis, so they can be on-line updated maps. In this case, the visualization can make both MoE (especially on the state of the organization and evaluation of actors) and MoP (the visualization the state of processes and used resources).

Marks of the present economic activities are their constant volatility. The time factor becomes a stimulus for progress. A significant part of the analyzes carried out in companies are based on the results achieved at certain intervals. With its own data on the state of the company, the time of implementation of individual operations, the feasibility of the production standards and statutory by individual actors is collected

considerable factual material, which should assist in modifying and improving the principles of functioning of the company. In addition, companies should have appropriate methods to collect data on the environment. This data can come from the Internet or be stored in CRM systems. They also should be organized and assigned to specific objects. Some of them may be suitable for spatial visualization, especially the data that have spatial attributes (eg. Maps of revenues per capita in individual municipalities or the density of customers in a given region).

By combining proprietary data from external (while maintaining an appropriate level of data security) can be made of various types of spatial visualization. A large part of the external data is largely based on time intervals.

Spatial visualization itself has to provide aggregate data on the state of the company and its unused capacity and resources. Using these visualization, this may facilitate the creation of new fields of business activities, the search for new areas of market expansion and improvement of the principles of functioning of a company.

VII. CONCLUSION

Theme adapter in the article is a research section in larger whole where this technology is used in Business processes of description. The main current research is thus aimed at integration of different systems data formats and ICT tools. However, it is difficult in this theme to skip the time factor in the development of the proposed tools.

Underlining the rule of time factor in business processes analysis causes necessity looking for the new tool, which let to prepare a more readable presentation. GIS tools can be integrated with different kinds of information system and use animation technics. So they can exemplify the time factor using spatial visualization. Using proposed MoE, MoP and classic geographic electronic maps is possible to develop information system for enterprise's management.

Presented proposal of using spatial tools is theoretical construction, but its preparation was preceded by market researches concerned on different types of information systems (mainly GIS applications and ERP/BI, CRM, AOT) and many business conversation with representatives of different occupational group (computer scientists, managers, GIS workers).

Computer scientists have largely confirmed certain openness of modern information systems and the ability to integrate with other systems. From a technical point of view, the creation of MoE and MoP is feasible. This is confirmed by experts in the field of GIS technology. Although state that at present the basic operation of GIS companies concerned to continue the popularization of the tools and explore new applications based mainly on geographical space. In turn, managers, mainly engaged approaches to the implementation of process management are interested in receiving the finished tools that facilitate their work. Whereas less interested in experiments with new tools, especially that it might generate some cost.

However, you can point out some advantages of the proposed tools compared to existing tools. These include among others, the possibility of simultaneous visualization and multi-functioning of the entire company and implemented processes. This initiative promotes the integration of different types of systems, and ultimately increases the effectiveness of communications systems within the enterprise and entire economic agreements.

The time factor indicated in these considerations as a factor facilitating the implementation and monitoring of business processes. In this case, the present solution is to encourage the motivation of individual participants processes for more efficient operation, thanks to a bright and clear rules on the evaluation of performed tasks that everyone can see him on the available types of maps.

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