Methodology for Modeling and Analysis of Business Processes (MMABP)

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Abstract: This paper introduces the methodology for modeling business processes. Creation of the methodology is described in terms of the Design Science Method. Firstly, the gap in contemporary Business Process Modeling approaches is identified and general modeling principles which can fill the gap are discussed. The way which these principles have been implemented in the main features of created methodology is described. Most critical identified points of the business process modeling are process states, process hierarchy and the granularity of process description. The methodology has been evaluated by use in the real project. Using the examples from this project the main methodology features are explained together with the significant problems which have been met during the project. Concluding from these problems together with the results of the methodology evaluation the needed future development of the methodology is outlined.

Key words: business process modeling, modeling language, ARIS, BPMN

1. Introduction

Business Process Management (BPM) is an important and wide used approach to business management. Substantive part of BPM is the Business Process Modeling. It covers several forms of description of business processes and several sets of rules for the description, usually formed in methodologies or frameworks. There are lot of methodologies for Business Process Modeling, used by different communities for different purposes, e.g. for analysis, design or automation of process flows.

In this paper we establish the problem which, as we believe, is not covered by contemporary methodologies for Business Process Modeling. Therefore, we state our methodology which deals with the problem, argue its relevancy, and describe way of its evaluation in real companies.

There are two most commonly used methodologies for business process modeling: Aris Method and BPMN.

Aris method has been developed by prof. Scheer and widespread by Aris modeling software. This methodology is based on process Y model and use Value Added Chain (VAC) model and Functions Allocation diagram for modeling process context, and Event Process Chain model (EPC) for modeling process flow. Particularly EPC modeling patterns were adopted by many companies as well as by many modeling tools and become de-facto standard. ARIS methodology is targeted at a corporation and its processes in the broadest sense.

BPMN is an open standard issued by Business Process Management Initiative together with Object Management Group. In current version BPMN 2.0 acronym stands for Business Process Model and Notation. BPMN standardizes several business process models especially for different types of process flow descriptions. The BPMN is more technical standard, suitable for more technical and strict process descriptions and for process automation in information systems.

The reason of our involvement is the fact that both of the mentioned methodologies, as representatives of many others, do not deal with some principles which we believe are natural for business processes and their models. This can result in creation of process models, which go against the nature of the BPM approach, such as improper use of hierarchy instead of flat process structure, improper or unsuitable level of detail of activity sequences, misunderstanding of service relationships between process and supporting processes etc.

The aim of this paper is to introduce the methodology for modeling business processes which has been used in the common project by the University of Regensburg and the University of Economics, Prague “Transnational Competence Center for Business Process Management” supported by the European Regional Development Fund.
The methodology has been created using the Design Science Method (Vaishnavi, V. and Kuechler, W., 2004). Our approach can be summarized in following five phases:

- Awareness of the gap in contemporary Business Process Modeling approaches.
- Suggestion of modeling principles which can fill the gap.
- Development of modeling methodology based on the mentioned principles.
- Evaluation of designed methodology by using it in a project.
- Conclusion.

Our awareness of the problem arisen in long term by studying and using Business Process Modeling in projects and in teaching. Our certain dissatisfaction with using modeling methodologies, namely Aris Design Method and BPMN, lead us to the formulation of the deficit in contemporary approaches to Business Process Modeling. The problem itself is described in chapter “The Problem”.

The methodology itself is described in chapter “The Methodology”. The methodology includes also the basic modeling principles we suggest. Those are stated in chapter “Basic Methodology Rules”.

We evaluated the methodology by using it to describe the process models of several businesses within our project of comparison the business processes between companies in two European regions, as described in chapter “The Evaluation”.

Following text is organized into 3 main sections. In the second section we describe the problem which led us to use of the methodology as well as to its accommodation to specific circumstances of the project. We regard the need for accommodation of the methodology to be a regular aspect of any case of using it. Therefore, we describe even the problem itself in terms of the generally valid specification of purposes for the methodology instead of regarding it just as a specific use case. Following, the third, section describes the artifact by means with which we solved the problem: the methodology for modeling business processes in order to identify main areas of possible improvement of the organization management in the process-oriented manner. In the fourth section we focus on the evaluation of the methodology using examples of process models from the mentioned project. Examples are completed by discussions of the manifestation of the main methodology features in real process models. The Conclusions section contains the paper summary together with the discussion of main benefits as well as limitations of the paper subject completed with the outline of further research.

2. The problem

In order to reflect the values of the process-oriented approach for the management of an organization, described and explained in (Hammer, M., Champy, J., 1993), (Davenport, T.H., 1993) and other basic resources, we have following requirement for the process modeling language and approach:

An essential attribute of a business process is a process goal which means that the business process is always an intentional process. Its primary purpose is to achieve the stated goal and all its behavior has to be targeted to this goal. This fact is documented in many basic resources like in (Eriksson, H.E., Penker, M., 2000) where the authors regard the process goal, represented by the process main artifact (key product) and linked to the strategy of the organization, to be a basic mandatory process attribute. To be intentional, to follow the goal, the process has to contain the feed-back relationship to its environment. Moreover, this feed-back has to be negative which means gathered information from the environment has to be used for influencing the future behavior of the process actors in order to target the process to the goal. This intention requires at first the restriction of all possible future process actions to just those of them which, in given circumstances at the given moment, follow the process goal. The fatal link between the intentionality of behavior and the negative feed-back is originally argued in the famous article (Rosenblueth, A., Wiener, N., Bigelow, J., 1943) and elaborated in the context of the business process modeling in (Repa, V., 2014). In order to realize the negative feed-back in the process description it is necessary to take into the account not only process activities but even the communication with other processes and actors from the process surroundings. As the process description has to respect, besides the contents and logical ordering of the process activities, even the factor of time which causes necessary linear ordering of activities, the process description has to respect particular places in the process structure where the process has to wait for the input information from other processes or actors in order to synchronize its internal logic with the internal logic of collaborating processes. These places are called process states and represent the waiting (staying) of the process for the input from its surroundings which is necessary for the decision about its future run. This way the idea of the negative feed-back is fulfilled.
The need for taking into the account not only the internal process logic but even its important surroundings discussed in the previous paragraph undoubtedly leads to the need for the global view of the process system as a complement to the internal process logic description. This view represents the system (i.e. non-algorithmic) model of the process and thus it cannot be substituted by the algorithmic process description. It shows which main processes the business system consists of and how they mutually interact. This global-system process model occurs in different methodologies under different names like process map in (Visual Paradigm, 2014), value-added chain in (Scheer, A. W et al., 1992), or even, lightly confusingly, process diagram in (Eriksson, H.E., Penker, M., 2000).

The system (global) process model and the internal (algorithmic) process description are two different views on the same business system. Therefore, these models have to be mutually consistent. Consistency in this case should cover technical aspects like need for synchronization of collaborating processes through process states as well as content aspects like respecting global attributes of each process, like the process goal, in the internal process contents (meaning of activities for instance).

From the practical point of view there are also some commonly occurring problems in process analysis projects which can be regarded as general or even chronic. These problems cause the need:
- to avoid the senseless details of the description very often occurring in process analysis projects and often resulting in inability to uncover the nature of the business,
- to set the same level of detail inside the analysis team in order to focus all its members to the common values.

Both identified problems have the same origin in the problem of the process description granularity and are both solvable in the context of previously discussed requirements for the process modeling language and approach.

From the point of view of these requirements we have analyzed both leading methodologies. The gap we identified in contemporary approaches to business process modeling and which we address in our suggestion can be divided into three parts:

1. Process states.

In Aris method, after every activity in the process chain an event is modeled. This “event object” should usually not be taken as a real event, as it has no external origin, and thus it rather represents a process state. In BPMN there is no concept of process state, but aside of the final state of process (the end), we can understand some gateways as representations of process states. We suggest that process states are essential for business process modeling and whenever the process flow awaits any input from outside the flow in order to continue, the process state should be modeled. This concept of the process state is closely related to events which are essential for the process flow continuation. Therefore, each state should be bound with an event. The awaited event may not occur and this situation should be captured in the process model too. In contemporary approaches it is possible to describe this situation in several ways, but it is not handled as pattern even if it occurs regularly in each process.

Both Aris method and BPMN contain the concept of a sub-process. This concept leads to misunderstanding of process management and modeling as it establishes a hierarchy between process and its sub-processes. But one of the essential principles of BPM is the difference between functional approach which is hierarchical and process approach which is of flat structure. Therefore, we believe that connections between processes should not be hierarchical but flat as among equals.

The main reason for process flow modeling is the process structure, which is done by branching and interactions with process neighborhood (other processes). Lack of specific rules in current approaches leads to the overuse of activity sequence in process flow models and therefore to incomparable and undefined level of granularity of process description.

Regarding the above described characteristics of leading methodologies we have found that they do not solve the above stated problem sufficiently. Therefore, we decided to create the own methodology using as much as possible the existing support: existing standards and related supporting tools.
3. The methodology

Our solution of the problems, outlined in the previous chapter is a methodology MMABP (Methodology for Modeling and Analysis of Business Processes) (Repa, V., 2012).

3.1 Basic methodology rules

The basic MMABP methodology rules for modeling the business process are:

1. Business process must have just one starting point in terms of time (i.e. it must start in just one time point). Business process must start with one or multiple events. If it starts with multiple events all they must be connected together in just one time point (i.e. every event must be either an alternative to other event(s) or it must be synchronized with them).

2. Business process must result in at least one end state (a Process End).

3. Business process description must reflect the natural need for waiting for the external influences in the form of process states. The process state represents the particular point in the process where the process expects some external influence (i.e. an event or some structure of events). When the process achieves this point it cannot do anything else than waiting for that influencing event.

4. Granularity of the process description is given by external influences on the process (and vice versa (recognized external influences on the process follow from the granularity of the view on the process)).

5. Consequently, every process activity represents the reaction on some event (external influence).

First three principles are given by the fact that business process is a process. It means that the process always has the time dimension which has to be respected undoubtedly. Therefore, every element of the business process has to be defined exactly and uniquely not in terms of meaning only but even in terms of time. Particularly, every action in the process as well as any event have to be unique in time which means that they have to be exactly anchored in the particular point of time. For instance, the start of the process, represented by the starting event, also represents a single time point no matter if it can be realized by just single event or by different possible events. In order to achieve the clear definition of the process start in terms of time it is therefore necessary to express exactly the mutual relations of all attending events: whether they are mutually exclusive (XOR) or, in turn, whether they have to be synchronized together (AND). Similarly, every place in the process where the communication with the process environment (other processes or external actors) exists has to be exactly anchored in time. This means that the process has to be waiting for the input in this place in order to synchronize its internal run with external entities which it is communicating with in the single time point. That is the nature of the “process states”.

The 4th principle solves the problem of the process description granularity. It defines the level of detail which has to be achieved in order to fulfill the other principles. From the opposite viewpoint it also defines the maximum detail which make the sense from the methodology principles perspective. This way the principle avoids the meaningless diving in details which is so typical for methodologically immature approaches to the process modeling.

- The only reason for dividing the activity to the sequence of sub-activities can be the need for expressing some external influence on the process in the form of incoming event. This means that any sequence of activities without a state (i.e. waiting for some external event) between them is incorrect.
- The only way how to express the compound activity is to express its details as a supporting process (instead of its hierarchical decomposition). This means replacing the compound activity in the process with the process state which express the waiting for the service from the supporting process. This rule supports one of the main ideas of the process driven management – the shift from the hierarchical (tree) to the flat (network) organizational structure.

Respecting the above stated rules we need to use two essential views on the business processes - two essential types of models:

- Global Process Model - Model of the system of processes (Process Map). This model describes which processes the business system consists of and how they can mutually communicate. This model represents the structural (static) view on the whole system of
processes. Essentially, there is the only model for the whole system (as the system itself is the one). In practice it may be useful to divide the whole system to several Process Areas and describe it with several process maps.

- In the ARIS Notation (Scheer, A. W et al., 1992) this model can be represented by the “Value Added Chain Diagram”.
- The official standard BPMI approach (BPMN, 2011) does not support this type of model by any diagram. The most frequent complement to the BPMN for this purpose is the Eriksson-Penker Process Map (Eriksson, H.E., Penker, M., 2000). In the ARIS environment it is better to use the “Value Added Chain Diagram” because it can be well combined there with other diagram types.

- **Detailed Process Model** - Model of the process flow (Process Description). This model describes which activities the processes consists of and how they ordered (i.e. placed in the structure of the process). This model represents the algorithmic (dynamic) view on a single process.
  - In the ARIS Notation (Scheer, A. W et al., 1992) this model is represented by the “Event-driven Process Chain Diagram”.
  - In the official standard BPMI approach this model is represented by the “BPMN Diagram” (BPMN, 2011).

### 3.2 Project environment

The MMABP methodology is intended to be independent of the “infrastructural aspects” of the business process modeling like modeling language and connected computer tools – CASE tools (Computes Aided Systems Engineering). It is aimed on the ability to accept any language, as well as supporting tool, which are not in strong contradiction with its principles. Instead of defining own language the methodology is based on the meta-model that expresses basic principles and modeling rules which have to be fulfilled by the modeling environment. This approach makes the methodology independent of any infrastructural aspects mentioned above and allows it to accommodate the environment of the given project if it meets its basic principles. For further explanation of the MMABP meta-model see (Repa V., 2003).

For the purpose of the project, mentioned in the Introduction section, the specific language environment in the ARIS Business Platform has been created. The environment consists of:

- Specific subset of the **VAC Diagram** (Value Added Chain) for the Global Process Model.
- Specific subset of the **EPC Diagram** (Event-driven Process Chain) for the Detailed Process Model.
- Specific restrictions and additions to models following from the used methodology (allowed types of connections among particular model objects, new objects, specific meanings of some objects etc.).
- Specific process patterns for the EPC Diagram which effectively support creation of models with respect to the methodology rules during the modeling process. These patterns should be used as modules for creating typical parts of the process model. Moreover, assembling process models from prepared standard modules standardize the point of view as well as the perception of business practices which strongly supports needed following consolidation and generalization of different models.

The language environment is packed in a “language filter” which is a usual way of customizing the modeling language in the ARIS Toolset. Implementation of basic diagrams from the ARIS methodology in terms of the MMABP principles is shown at Fig. 1 and Fig. 2.
### 3.3 Process patterns

Business Process Patterns in the MMABP methodology express the general solutions for typical situations occurring in the process of modeling the business processes. Business Process Patterns complete the methodology with the further information about how to create models which are
consistent with its principles and rules. They can be also used as the general examples of typical segments which the business process should consists of. These segments can be instantiated for the particular situations and used as basic building blocks of the business process model.

There are two main kinds of Business Process Patterns in the MMABP methodology:

**Basic Process System Pattern (global view on the process system)** which defines the basic elements and structure of the system of processes. It expresses the main idea of subordination of supporting processes to supported ones targeting on the basic (key) values for customers.

**Basic Business Process Flow Pattern (detailed view on the process flow)** which defines the basic procedure and decision points in the process of creation the model. This pattern is essential in the MMABP, it expresses the main principles, rules, and other aspects of the MMABP approach to the business process modeling. This pattern serves mainly as an expression of the principal process structure, it consists of many abstract elements and therefore cannot be directly used as a building block thus it is the only pattern which is not implemented as a “pattern” in the “language filter”.

**BP patterns for particular situations (detailed view on the process flow)** which cover typical situations occurring frequently in business process flow models where it is possible to find some generally valid structures, principles and constructions which should be fulfilled by the process description undoubtedly. In following paragraphs we describe in detail two first basic patterns. Detailed description of specific MMABP patterns for particular situations can be found in (Repa, V., 2014).

### 3.4 Basic Process System Pattern

This pattern defines the basic elements and structure of the system of processes. According to the main idea of process-driven management all processes in the organization should be derived from its key products, i.e. from the values delivered to customers. Therefore, the central part of every model of the process system should consist of the key process(es) (red colored) which are directly connected with the strategy of the organization (supporting one or more strategic goals) and are producing one or more key products. All supporting processes are producing services which are requested by supported processes by the interprocess flows (see the pattern at Fig. 3).

Meaning of the key process is thus given absolutely by its key product(s) while meaning of every supporting process is given relatively: it is derived from its meaning for the processes which it supports.

![Fig.3. Basic Process System Pattern](image-url)
3.5 Basic Process Flow Pattern

This pattern defines the basic general structure and rules for creating a process flow model. These rules are described and explained by examples below.

The pattern consists of five definitions:

Def (i): Process flow begins with starting Event block followed by the Process Body.

Def (ii): Event block is either a single event, or structure of mutually exclusive Event blocks, or structure of mutually synchronized Event blocks.

Def (iii): Process Body is one or more pairs when each pair consists of an Activity block followed by either State block or End State.

Def (iv): Activity block is either a single Activity, or structure of mutually exclusive Activity blocks, or structure of parallel Activity blocks.

Def (v): State block is a synchronization of internal process flow with expected event(s) expressed as an Event block (in other words: waiting for the event(s)).

Fig. 4. Basic Process Flow Pattern

The contents of this pattern can be simply expressed as follows: "Business process should be described as a sequence of Activity blocks interrupted by State blocks starting with just one Starting Event block and resulting in one or more End states."

General example of the process flow which fulfills the basic structure and respects the rules expressed by this pattern follows (see Fig 5).

Fig. 5. Symbolic example of process flow
Fig. 5 shows the symbolic example of the process which can be regarded as correct according to the Basic Business Process Flow Pattern. The process can be seen as a sequence of several parts each representing one block of a particular basic type (see the division of the whole process by vertical dashed lines). It is beginning by the starting event block which consists of just single event E1 in this case – the starting event of the process. The staring event is followed by the activity block consisting of just single processing activity A1. According to the pattern the activity block is followed by the state block in the form of synchronization of the process run with just a single event E2. Following activity block represents more complex structure of four activities A2 to A5. Following state block represents the waiting for two alternative events E3 or E4. The last activity block is a structure of two alternative activities followed by corresponding process ends.

The example illustrates that and how any algorithmic structure of the process can be checked whether it fulfills the basic definition of the business process expressed by the Basic BP Flow Pattern: business process is a sequence of Activity blocks interrupted by State blocks starting with just one Starting Event block and resulting in one or more End states.

4. Evaluation

The usage of the methodology have been evaluated in the international project of University of Regensburg and University of Economics Prague. In this chapter we describe the background of the project and our approach to the methodology evaluation together with the results of the evaluation. The methodology as described above, was adopted as modeling standard for analyzed processes. As a modeling tool for the project the Aris Design Server and Aris Business Architect were chosen which both universities are licensed for research usage. Methodology rules and principles were supported by setting of the Aris Design Server filter.

The methodology was used by different analysts to describe business processes of selected companies. The analysis was performed by interviews with management of the companies and then with process actors. The analysts modeled their understanding of the process is performed in the company, and thereafter the model was verified and updated by following interviews. The methodology was evaluated on real production companies. We are allowed to publish anonymized parts of process structure, but we are not allowed to publish company names and process products and goals, regardless they were modeled in the global process models, therefore we do not publish examples of the global process models here.

In this chapter we show fragments of the real company analyzed processes to illustrate some situations the methodology was suitable. We selected three fragments of two processes in two companies to show. The overall process diagrams are shown for global process overview only.

Fig. 6 shows a process state handling of complementary events. After negotiating time and price of a product the continuation of the process is dependent on external, here customer’s reaction or inaction. In case of positive reaction the flow continue horizontally, in other cases (refuse or inaction) the order is canceled.

![Fig. 6. Fragment: Waiting for customer reaction](image)

The fragment at Fig. 7 describes situation, when truck came to the stock to pick up products or the truck is awaited but it is not present. Following activity block shows that if release notes are ok for incoming truck, the truck is loaded and process end in state the product shipped (and continues down to await the delivery to the customer, which is activity outside the company). If the truck is not present
for load, or other truck is present by mistake (the release notes do not fit), the spedition is re-planned and process end in the state spedition re-planned.

Fig.7. Fragment: Load Truck

Both example fragments are parts of process Customer order management which was analyzed in company A and which overview diagram is shown at Fig. 8.

Fig.8. Company A process – Customer order management

Fig. 9 shows Invoicing as ending fragment of company B process. After invoicing, the process awaits till the invoice is paid or payable. If paid, the order is closed, if not, the invoice is reminded or the debt is enforced by starting another process. After the enforcement is finished, the contract is closed or debited. This example illustrates connection to other process and waiting for its result.

Fig.9. Fragment: Invoicing

The invoicing fragment is a part of process Market opportunity management which was analyzed in company B. The overview process diagram is shown at Fig. 10.

The aim of the evaluation was to test the usability of the methodology in real life, so the fact that it was easily possible to capture the processes leads us to take the methodology as basically evaluated.
5. Conclusions

In summary, we felt the contemporary process modeling methodologies leave a gap within modeling principles, which could be filled by concentrating to negative feedback in processes to focus to meet process goals. To fill the gap we use design science approach to propose a methodology which contains patterns addressing the aspects of the gap, such as process states, hierarchy and granularity. We described the methodology principles and patterns and evaluated the methodology by using it in a real project.

In the project the methodology helped to capture all of the process relations to the outside of the process in the way of the both positive and (in particular) negative feedback, the granularity of process description was kept in desired detail and the hierarchy of processes was not established as the processes were kept on the same level of hierarchy. Therefore we consider the methodology fit for the purpose.

Nevertheless, some limitations of the methodology arisen.

- **Granularity rule** is sometimes too strong, there are some possible situations which may require some accommodation of the process model granularity:
  - For the first outline of the process contents it may be suitable to keep higher level (i.e. lower granularity) with the assumption of going to more detail later.
  - For the mutual understanding with business people the analyzer needs sometimes describe precisely the “current state of the process” containing even unnecessary details in order to make the description close as much as possible to their point of view. Later in the project, when both sides understand the model the same way, these details can be omitted according to the methodology rule.

- **Process states** may complicate the understanding of the process contents by business people as the states-oriented process models represent in many cases rather the desired view of the process than the business people's point of view.
  - For the first outline of the process contents it may be suitable to omit process states. The model then describe the activities flow only ignoring the needed communication with the process environment.
  - The states will be taken into the account later in the project when there is already some notion about other processes and actors communicating with the process.

In future research we plan to evaluate the methodology and its principles in more detail. While suitability of the methodology for its purpose we take as evaluated, there is still a gap for testing the
usage of the methodology by studying its usage in comparison with usage of other modeling approaches and its usage by different process analysts. Modeling processes within rules of this methodology shown that the modeling of certain situations can capture repetitive patterns (e.g. the Invoicing in one of the examples) probably more easily than in case if the modeler is not bound by the methodology rules. Our planned future work encompass searching for those patterns in real processes, model or re-model them in our methodology and studying them.

Acknowledgements

The project which this paper is based on has been supported by the European Regional Development Fund in the Goal 3 program Interreg IV - Bavaria – Czech Republic.

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JEL Classification: M10