The Formalization of the Business Process Modeling Goal (draft)

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Abstract. In business process modeling the de-facto standard BPMN has emerged. However the applications of this notation have many subsets of elements and multitude of extensions and it still coincide with many other modeling languages, forming a large set of available options for business process modeling languages and dialects. While in general, the goal of modeling is a central notion in choice of modeling techniques, in the most of researches that propose guidelines, techniques and methods for business process modeling language evaluation or/and selection the business process modeling goal is not formalized and respectively not transparently taken into account. To overcome this gap, and to explicate and help to handle the business process modeling complexity, the approach to formalize the business process modeling goal and the supporting three dimensional business process modeling framework are proposed.

Keywords: Business process modeling, business process language, business process modeling goal, business process modeling framework.

1 Introduction

Nowadays business process modeling application areas are rapidly expanding [1]. As a result, enterprises are faced with a situation where the same business processes are modeled for different purposes [2]. On the other hand, a number of the studies [3], [4], [5], [6], [7], [8], [9] indicate that particular business process modeling languages are appropriate for a certain business process modeling goals. The question arises, how to find a modeling language that is suitable for a certain modeling goal. The selected modeling language must have modeling constructions to represent business process from certain perspective, as well as make it possible to model a business process with a certain degree of precision and formalization according to the required level of abstraction. Interdependencies between business process, modeling goal and modeling language can be represented in the form of a triangle (Figure 1).

Looking at different researches that propose guidelines, techniques and methods for business process modeling languages evaluation or/and selection, one can conclude that the business process modeling goal is not formalized and respectively is not transparently taken into account when selecting a modeling language. The modeler has to itself decide what characteristics of the modeling language are more suitable for a particular modeling purpose, or the research authors offer a certain modeling language for certain modeling tasks without verification and evaluation of possible alternatives.
The paper proposes the way how to formalize the business process modeling goal, specifying what parameters should have the desirable business process abstraction. As a result, business process modeling languages can be evaluated according to the values of the modeling goal parameters. In order to identify the values of the modeling goal parameters the paper proposes Business Process Modeling framework.

The remainder of the paper is organized as follows. In Section 2 the related work is outlined. In Section 3 the business process abstractions types are described. In Section 4 the proposed approach for formulization of business process modeling goal and supporting business process modeling framework are proposed. Section 5 illustrates how Business Process Modeling Framework could be used for specification of the modeling goal’s parameters. Brief conclusions are presented in Section 6.

2 Outline of Some Related Works

Analyzing the different researches that propose guidelines, techniques and methods for business process modeling language evaluation or/and selection, it is possible to classify proposed solutions into several groups. One group of solutions, such as [10], [11], [12], [13], [14], offers to estimate business process modeling language characteristics. But it is not explained with what characteristics should be modeling language in order to be suitable for a particular modeling purpose. Others researches offer to use particular business process modeling languages for certain modeling purposes (e.g., [4], [8], [9], [15]). However, the choice of the modeling language is mostly based on the author's subjective opinion. Another category of solutions (e.g., [16], [17], [18], [19]) offers to adapt business process model content to new modeling purpose, using various techniques such as changing the level of granularity, reducing unnecessary details or generalizing the content of the model. Finally, there are solutions that provide transformations between different abstraction levels [20], [21], [22], [23], [24], [25], for instance, the conceptual models are transformed to realization models according to Model Driven Approach (MDA) approach [26]. Each abstraction level is realized by certain modeling language, and the choice of this language is no clarified.

Above described solutions for evaluation or/and selection of the business process modeling languages are estimated according to how they take into account the modeling goal: either the solution just considers the modeling goal or the solution, in addition, provides the way how to formalize the modeling goal. Results of the evaluation are summarized in Table 1.

Table 1. The evaluation of the solutions for business process modeling language selection and/or evaluation

<table>
<thead>
<tr>
<th>No</th>
<th>Modeling language evaluation or/and selection solution</th>
<th>Goal is considered</th>
<th>Goal is formalized</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Use of certain modeling languages for certain modeling goals [4], [8], [9], [15]</td>
<td>+</td>
<td>-</td>
<td>Fixed modeling languages for certain tasks of the business process management lifecycle</td>
</tr>
<tr>
<td>2.</td>
<td>Selection of the modeling language using BWW ontology</td>
<td>+</td>
<td>+</td>
<td>Intersection of the modeling goal and the modeling</td>
</tr>
</tbody>
</table>
In Table 1 it can be seen that a large part of the solutions do not provide the selection of the modeling language according to the modeling goal. Additionally, only one solution [27] offers a way how to formalize the modeling goal. The authors of this solution propose initially to determine what real-world things should be modeled and then to estimate if modeling languages provide appropriate syntactical constructs to model such real-world things. This is achieved by defining the intersection of the modeling languages and modeling goal for this purpose using the Bunge–Wand–Weber (BWW) ontology. However, [27] only particular aspects of the business process modeling goal are considered, disregarding other characteristics such as required abstraction level, precision and formalization degree. Additionally in [28] BWW ontology has been criticized, since it is designed at too high level of the abstraction, making it inefficient for detailed characterization of the modeling goal.

Based on the estimation results, it can be concluded that most of the solutions do not provide the formalization of the modeling goal in sufficiently. The modeler should decide which modeling language is more suitable for a particular goal or to use the offered modeling language without justification and estimation of the alternatives.

3 Business Process Abstraction Types

A natural way to learn about the world around us is its modeling. When we create models, the subject under the research is replaced by another mental or physical object, which is more convenient, safer or cheaper to use than the original. According to such general explanation of the model any kind of modeling requires the creation of the abstraction of the research object. In a general sense, abstraction is understood as highlighting of the important properties of the research object or phenomenon and ignoring unimportant properties or creating the general concepts or ideas from the set of objects or facts [29]. Abstraction facilitates understanding of complicated things, replacing the real object with a simplified and generalized representation, e.g., the model of that object. There is a number of abstraction techniques, but analyzing the business process modeling language specifications (BPMN, DFD, IDEF0, EPC, UML AD, etc.), and business process modeling framework documentations [30], [31], [32], [33], [34], it is possible to identify three most commonly used business process abstraction types:

- Filtration of the business process elements according to the certain modeling perspective.
- Generalization from the details about the business process execution according to the selected level of the uncertainty.
- Reducing the complexity by "hiding" the part of the business process in the lower level of the decomposition.

Each of these types of business process abstraction is discussed in more detail in the according subsections.
3.1 Perspective

Real business process has an infinite set of different elements. Creating business process abstraction, a final set of elements is selected, eliminating others one. The unnecessary elements are filtered according to the defined criteria. In the case of the business process modeling, these criteria are often replaced by the concept of perspective that is the viewpoint from which the observer explores certain part of the research object without seeing others parts [35]. The business process model that is created from certain perspective is called as view [36], [26].

Sometimes in the literature perspective concept is replaced by other similar terms, such as viewpoint and aspect. Aspect is certain part of the subject that is visible from a certain position [26]. Viewpoint is a position from which an observer sees only certain part of the object or estimates the phenomena of the surrounding world [29]. As can be seen, these concepts are semantically similar and interchangeable.

When modeling the same business process from different perspectives, the business process is studied in the "width". In other words, derived number of several models creates a comprehensive impression of the business process, in such way exploring the different parts of the business process (Figure 2).

![Diagram of business process modeling from different perspectives](image)

**Figure 2.** Business process modeling from different perspectives

3.2 Generalization

Another business process abstraction technique is a generalization. Depending on the purpose of the modeling, the same business process can be modeled with different precision. The degree of uncertainty of the business process modeling is selected according to the level of generalization. In the lowest generalization levels the business process model includes the most details about the business process execution, in such way minimizing the uncertainty and inaccuracy. In the highest generalization levels the model is created with coarser granularity and is less meaningful in content. This may be achieved, for example, by increasing the degree of uncertainty, abstracting from implementation details, dissembling the obvious things, ignoring the insignificant differences and generalizing the similar behavior. Using generalization technique it is possible to create a multi-layer model of the business process. Between the lowest and the highest generalization levels there is a link "is the concretization", that is, lower level models are more accurate representation of the higher level models. One and the same business process modeling at different generalization levels is schematically presented in Figure 3. In instance, the same business process may be modeled initially at the conceptual level and then at the analysis or execution level.
3.3 Decomposition

One more way to hide unnecessary details is decomposing the business process into the sub-processes. Every sub-process is a set of the business process activities that is "hidden" at lower level of detail, thus simplifying the understanding of the complex business process. The concept of decomposition sometimes is replaced by the concept of granularity, which is the degree to which the process is broken down into smaller components [36]. The coarse-grained business process consists of a smaller number of the components that are larger in size. In contrast, the fine-grained business process is divided into the larger number of components that are smaller in size.

In the case of the generalization each level of abstraction is created as individual model, but in the case of the decomposition usually one model that is divided into different decomposition levels is created. Between the models in the upper and lower decomposition levels there is a relationship "is a composition" or "consists of". Modeling of one and the same business process at different decomposition levels is schematically presented in Figure 4.

4 Formalization of the Business Process Modeling Goal

By analyzing several business process modeling language specifications (BPMN, DFD, IDEF0, EPC, UML AD, etc.) and business process modeling framework documentations [31], [32], [33], [34], [35], we have found that, in order to create the business process model for a particular goal, all three types of abstraction mentioned in Sections 3.1-3.3 should be used. Consequently, any business process modeling goal may be formally described by three parameters: perspective - from what viewpoint the abstraction should be designed, generalization level - with what degree of uncertainty the business process should be explored and decomposition level - the necessary
granularity of the business process model. According to that argument, the business process modeling goal can be defined as follows:

“Business process modeling goal is to create the business process abstraction from a certain perspective, in the appropriate generalization and decomposition levels. Business process modeling goal is described by the expression \( M_{BP} = \{GL, DL, P\} \), where \( M_{BP} \) is the business process modeling purpose, \( GL \) is the generalization level, \( DL \) is the decomposition level and \( P \) is the modeling perspective.”

In this paper the Business Process Modeling Framework that could be used for specification of the business process modeling goal’s parameters is proposed. This framework is developed by amalgamating business process modeling knowledge available in resources of IEEE, ACM, Elsevier, Springer and other sources. The architecture of the Business Process Modeling Framework is shown in Figure 5. The framework has three dimensions that are defined according to the modeling goal’s parameters. Generalization and decomposition levels are the vertical dimensions, and perspective - a horizontal dimension. Each framework dimension has appropriate "scale" of "values" shown with the abbreviation \( GL_i \) - for generalization, \( DL_i \) - for decomposition, and \( P_i \) - for perspectives. By modeling the business process at the certain generalization and decomposition levels and from a certain perspective, the business process model that meets the requirements of certain modeling goal can be obtained.

**Figure 5. Business process modeling framework**

The scale of the generalization dimension is obtained by analyzing the business process modeling goals that are described in scientific papers and books. For this purpose 70 information sources were analyzed. It was determined that the business process modeling goals are intended to create business process model at the following generalization levels (Figure 5):
GL1. Overview level – is appropriate for modeling goals that intend to create the graphical representation of the business process. In other words, the holistic view of the company's key business processes should be created, including collaborative business processes with external partners and/or customers. Usually the information of all key business processes is reflected in one model thereby the high level of abstraction is required in order to compensate the complexity caused by a large number of elements. The overview level may be useful for managers and business analysts.

GL2. Descriptive level - is appropriate for modeling goals that also intend to create the graphical representation of the business process. However, in contrast to the previous level, instead of modeling all key business processes, a certain business process should be modeled. The graphical representation of the business process should be created with such precision that is appropriate for business process documentation, communication with customers, staff training etc. Created graphical representations must be relatively simple, intuitively understandable, avoiding self-evident things, ignoring unnecessary implementation details and without the strong syntactic rules. The created models may be useful for different levels of managers, process owners, business analysts, customers, partners, and other employees.

GL3. Qualitative (visual) analysis level - is appropriate for modeling goals that intend to visually analyze the various business process aspects. In this level the business process maturity is gradually increased. Business process model is enriched with details that are required for analysis of the business process characteristics from different perspectives in order to identify process improvement opportunities, to specify the requirements for the support systems, to identify outsourcing opportunities, to identify possible business services and etc. Thus, it is necessary to develop the "rich" and sufficiently precise model that could be used for obtaining the useful conclusion about the business process improvement opportunities. At the same time the created models must be sufficiently intuitive, so that they could be used to interact with the business people. Models developed at this scale may be useful for business analysts.

GL4. Quantitative analysis level – is appropriate for modeling goals that intend to analyze the business process by the quantitative methods. So, in contrast to the previous level, the analysis is based on numerical indicators rather than on the visual evaluation of the graphical representation. The created models are designed for restructuring, improving and optimizing the business process according to the quantitative results of the analysis, e.g., to reduce costs, to provide a more efficient allocation of resources, to improve customer service, to identify the value added processes, to optimize the structure of the process etc. The business process should be modeled in detail by creating formal parameterized models that can be used for the analysis with mathematical or analytical methods. Models created at this scale may be useful for business analysts.

GL5. Logical design level - is appropriate for modeling goals that intend to design the business process automation. The logical design level focuses on the business process support with IT. In other words, it is important to precisely model those business process parts that will be supported by the process aware information systems [37], such as workflow management systems, business process management systems, e-commerce systems and etc. In the result the developed graphical representations could be transformed into executable language. Thus this level is appropriate only for business processes that are modeled in sufficient detail and their descriptions are verified and validated according to certain quality criteria. Created models may be useful for technical analysts and designers.

GL6. Physical design level - is appropriate for modeling goals that intend to create the executable business process descriptions that could be transformed into IT artefacts (such as database objects or program code). At this level business process description has the largest number of details and the highest degree of the accuracy and formalization. That is because
the business process model is enriched with details that are necessary for the model transformation into the program code. Thus, additional validation restrictions are required at this level. Created models may be useful for technical analysts and designers.

Comparing business process modeling language specifications, process classification structures and enterprise architectures we have concluded that the most complete hierarchical structure of business process decomposition is proposed in [38]. These decomposition levels are used here to define the scale of the decomposition dimension in the Business process modeling framework:

- **DL1. Business process map** - includes the enterprise's top-level business processes such as customer service management, supply chain, human resource management, accounting, etc. At this level the business processes internal structure is not modeled, representing processes as "black boxes". This level is closely associated with the company's strategies and operational goals. It is possible to describe not only the execution sequence of the top-level business processes, but also to show another links, such as decomposition, calling, specialization.

- **DL2. Business process variant level** - represents the division of the top-level business processes into elementary business processes that belongs to the same group or reflects the various variants of the same top-level business process. Elementary processes belong to the same group, if they realize the same modeling goal but differ in the manner in which this goal is achieved. Additionally, the elementary business process can represent the different alternative versions of the top-level business process, for example, the several variants of the TO-BE models. Also at this level the business processes internal structure is not modeled.

- **DL3. Business process contextual level** - describes a certain business process execution context, defining business process customers, the basic values that are created, resources that are used, main partners and etc.

- **DL4. Business process level** - the first level that represents the business process internal structure (the business process is modeled as a "white box"), with clearly defined process borders, describing the possible execution paths, decision points, used resources and etc.

- **DL5. Sub-process level** - in this level detailed modeling of the certain fragment of the business process is performed. In other words, the purpose is to divide the business process activities into the lower levels of decomposition, thus reducing the complexity of the business process model.

- **DL6. Activity level** – in this level the certain process activity is expanded, reflecting all the necessary information for carrying out the activity, e.g., performers, time constraints, resources, conditions, restrictions and etc.

It is possible to distinguish a standard perspectives and user perspectives. User perspectives can include any set of business process elements depending on the domain of interest. They are defined by modelers, specifying what business process elements belong to a particular perspective. These perspectives are not discussed below, but can be added to the perspective scale, if necessary. Standard perspectives are formed by pre-defined set of the business process elements. The following standard perspectives are proposed in the related work [40, 41]:

- **P1. Functional perspective** – to represent which process elements are being performed, and what flows of informational entities (e.g., data, artifacts, products) are relevant to these process elements.

- **P2. Behavioral perspective** – to represent when process elements are performed (e.g., sequencing), as well as aspects of how they are performed through feedback, loops, iteration, complex decision-making conditions, entry and exit criteria.

- **P3. Organizational perspective** – to represent where and by whom in the organization the elements of a process are performed, the physical communication mechanisms used for transfer of entities, and the physical media and locations used for storing the entities.
• **P4. Informational perspective** – to represent the informational entities produced or manipulated by a process; these entities include data, knowledge, artifacts, products (intermediate and end ones), and objects; this perspective includes both the structure of informational entities and the relationships among them.

• **P5. Strategic perspective** – to coordinate and integrate the activities of various functional areas of a business in order to achieve long-term organizational objectives.

• **P6. Commercial perspective** – to represent how a business process interacts with an external environment or, in other words, which relationships exist between an organization and its customers and suppliers.

• **P7. Technological perspective** – to represent the quality means supporting the execution of tasks; the extent to which technical means offer appropriate support to the execution of tasks; the ability to adapt the technological means to changing circumstances.

• **P8. Housing perspective** – to represent the location of departments and geographical distribution of customers; the support of the office environment to the execution of tasks and business process.

• **P9. Financial perspective** – to represent the cost of process execution.


To illustrate how the Business Process Modeling Framework could be used for the definition of the modeling goal’s parameters, the bank business process "Crediting the legal persons" is considered. It is modeled according to the following four objectives:

• Initially, according to the new strategic objectives, the bank has decided to concentrate on the crediting of the legal persons. Business process "Crediting the legal persons" is becoming a main value added production line. As a result the business process is reorganized so as to ensure maximum support for legal persons.

• In the second case, the bank has decided to document the restructured business process "Crediting the legal persons" in order to develop procedure descriptions for employers. These descriptions will be used to train the responsible employees according to new procedures.

• In the third case, the model of the business process "Crediting the juridical persons" is used to define required knowledges, skills and responsibilities that are necessary to carry out each activity in the process.

• Finally the bank has decided to develop a web service for improved business process "Crediting the legal persons". For this purpose, initially, the detailed description of the business process should be developed using appropriate modeling language, and then it should be transformed into executable model.

The first modeling goal is related to the strategic analysis, the second – to the business process documentation, the third – to the personnel training and the fourth – to the development of the application. These various business process modeling cases are illustrated in Figure 6.
Figure 6. The modeling of the business process “Crediting the legal persons” according to different modeling goals

As can be seen from Figure 6, each of the modeling goals is intended to create different business process abstractions. Table 2 summarizes the requirements for the business process parameters according to appropriate modeling goals.

Table 2. The values of parameters of the modeling goals according to the Business process Modeling Framework

<table>
<thead>
<tr>
<th>No.</th>
<th>Modeling goal</th>
<th>Perspective</th>
<th>Generalization level</th>
<th>Decomposition level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Analyze the business process efficiency and effectiveness according to key performance indicators (KPI)</td>
<td>Behavioral, organizational, strategic, commercial perspective</td>
<td>Quantitative (formal) analysis level</td>
<td>Business process level</td>
</tr>
<tr>
<td>2.</td>
<td>Document business process</td>
<td>Behavioral perspective</td>
<td>Descriptive level</td>
<td>Business process level</td>
</tr>
<tr>
<td>3.</td>
<td>Define required knowledges</td>
<td>Informational perspective</td>
<td>Qualitative (visual) analysis level</td>
<td>Business process level</td>
</tr>
<tr>
<td>4.</td>
<td>Develop web service</td>
<td>Technical perspective</td>
<td>Logical design level</td>
<td>Business process level</td>
</tr>
</tbody>
</table>

As can be seen from the Table 2, for the first modeling goal it is necessary to develop sufficiently detailed and formal business process model that can be used for analysis and simulation. For the second modeling goal it is necessary to build a sufficiently simple and general model at the high level of abstraction. The third modeling goal is intended to develop model that could be used for the visual analysis. And finally, the forth model should be created for the “machines” rather than for the people. Thus it should be developed as the detailed, unambiguous, verified and machine-readable representation of the business process.

Creating the business process models at the description level, the attention should be focused on the understanding of the reality, and it is not desirable to spend the time to understand how to use the modeling language. Thus, the modeling language should be intuitively understandable and easy in use. In contrast, creating a business process models at the logical and physical design levels, there is no need to spend time to create readable and easy understandable for business executives models. Thus, the modeling language should be formal and executable.

It is possible to define a minimal set of business process modeling language elements for each value of business process modeling goal parameters (discussion of this issue is beyond the scope of this paper). When the set of language elements is known, the language that is most close to this set of elements can be chosen.
6 Conclusions

On the basis of analysis of business process modeling language specifications and business process modeling framework documentations it has been identified that the abstractions (models) of the business process are usually created using the following techniques: generalization, decomposition and modeling from a particular perspective. This paper offers to use these abstraction types for the formalization of the business process modeling goal. For better usage of the modeling goal’s parameters the Business Process Modeling Framework is proposed. Using this framework a modeler can choose the perspective and the levels of the generalization and decomposition.

In the future researches appropriate metrics and algorithms for evaluating how modeling languages conform to the selected values of the modeling goal parameters should be developed. For example, in order to evaluate to which extent the business process modeling language conforms to the desired perspective, it should be measured whether the modeling language offers syntactical constructions for all necessary business process elements. But in order to evaluate the conformity to the required generalization level the flexibility and multiplicity of the modeling language should be evaluated. That is, modeling at the highest generalization level, the modeling language should be the most flexible and provide for each business process element only one syntactical construction. It is different when modeling at the lower generalization levels.

The proposed solution uncovers complexity of business process modeling and is the first step towards development of a support system for evaluating conformity of the business process modeling languages according to particular modeling goals, as a result helping to handle the business process modeling complexity.

The developed framework is planned to be further verified using the business process modeling case studies that are described in the scientific literature. It will be evaluated is it possible in a sufficiently large number of cases to specify defined modeling goals according the proposed Business process Modeling Framework.

References


