

# THE APPROACH OF TRANSFORMATION BETWEEN BUSINESS PROCESS DIMENSIONS IN BPMN MODELING TOOL

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**Abstract.** Most popular business process modeling tools that support BPMN standard provide functionality of creating one or two dimensional process models, however, without possibility to transform created BPMN model to other dimensions. The paper describes the approach of switching between business process dimensions that could be implemented in BPMN modeling tool as advanced feature. The functionality of switching between process dimensions may contribute to the business process modeling and analysis from different perspectives in one environment. To make the transformation between business process model dimensions possible it is required to define additional attributes of the BPMN model graphical elements. The aim of the paper is to describe how BPMN model elements need to be parameterized for switching between dimensions in any BPMN modeling tool.

**Keywords:** business process modeling, modeling dimensions, BPMN, modeling tool.

## 1 Introduction

A business process is a set of coordinated activities that are performed either by people or by tools with an objective to realize a certain business result [1]. To define how the process works it is crucial to develop the process model, which will define the existing process flow in detail. Knowing and understanding the details of business processes is important, because this gives the opportunity to identify the bottlenecks and optimize business processes. To reveal all the details of the business process it is necessary to analyze the process from different point of views, within different contexts, i.e., from different dimensions/perspectives. It means that the process that is represented, e.g., from performer's dimension is hiding in its structure the details about the process from the time perspective. In most of the BPMN tools the only way to obtain business process model constructed from a particular perspective in other dimension is to redraw the process diagram. Apparently this solution is time consuming, not effective and may create errors in the process semantics.

The paper presents the idea of automatic business process model transformation between process dimensions within a BPMN modeling tool. The BPMN modeling tool is any tool that support BPMN standard, however in for obtaining model in several dimensions it is necessary that the tool allows to define additional attributes to the graphical elements as the idea of transformation between dimension is based on the refinement of the BPMN model by parameterizing its elements with additional information. BPMN is a chosen standard because it uses the concept known as "swimlanes" to help partition and organize activities. The idea of presenting business process in a new dimension is to organize model elements in the different way using swimlanes in order to reveal important details typical to the new dimension. The other reason is that BPMN quickly established itself as the standard notation for modeling executable business processes [1].

The paper is structured as follows. The overview of tools supporting multidimensional business process modeling is presented in Section 2. The approach of the transformation between dimensions is analyzed in Section 3. The requirements for the modeling tool with multidimensional process modeling functionality are presented in Section 4. The experimental example of transformation between process dimensions is presented in Section 5. Conclusions and future work is described in Section 6.

## 2 Related works

Multidimensional modeling capabilities of current business process modeling tools are quite limited in a sense that in most cases changing modeling dimension or perspective means creating new business process models. Only few tools allow limited automatic transformations for multidimensional modeling purposes [2]. One of such tools is JOpera [6] that supports visualization of control and data flow views, however these representations are independent and cannot be transformed one to another. In JOpera tool [6] the control and data flow graphs of a business process are displayed and edited separately [2]. Multidimensional modeling capabilities of BPMN tools are even more limited and in most cases they support multidimensional modeling by allowing two lanes to overlap (e.g. horizontal and vertical lane) – in that way creating two dimensions – such tools are MagicDraw [7] and ProcessModeler 5 [8].

Several business process analysis tools, such as Oracle BPA [9] provide capabilities for simulating processes [1]. Business process simulation starts by adding special parameters to process activities and events –

this refinement would allow to carry out simulation [1]. This idea of refinement business process model with special attributes to enable transformation is used in this article.

### 3 The approach of the transformation

#### 3.1 Determining dimensions

In business process modeling phase it is essential for process model to reveal the following basic information about each of the activity performed in the business process [1]:

1. Roles responsible for carrying out each activity in the process
2. Start time/end time of the process and processing time of each activity in the process
3. Documents exchanged within the process (inputs and outputs of each activity),
4. Business rules that control the workflow

In this paper each of above mentioned slots of information is regarded as business process modeling dimension. According to each of these dimensions a process model can be created and then transformed to another dimension without losing process semantics, using BPMN syntax and revealing information about the process in new context. Table 1 describes the business process dimensions in more detail.

**Table 1. Descriptions of dimensions**

Dimension name	Description
Performer dimension	Specifies which resource is responsible for carrying out each activity in the process. The performer dimension may involve human actors, devices and systems.
Time dimension	Defines the execution order of activities in the process according to time granularity (months, weeks, days, hours and so on) chosen by modeler.
Business rule dimension	Defines which activities are controlled by business rules and where in the process key business decisions are made.
Information dimension	Defines activities which use for input artifacts produced in the business process and activities that create as their output business artifacts.

#### 3.2 Correlation between BPMN elements and dimensions

BPMN is a visual language used for business process modeling, and uses a set of graphical elements. BPMN provides four basic categories of elements [3]:

1. Flow objects – events, activities, gateways
2. Connecting objects – sequence flow, message flow, association
3. Swimlanes – pools, lanes
4. Artifacts – data object, group, annotation.

In this paper BPMN is selected as the notation for representing business process model in different dimensions based on the following statement in the BPMN specification [3] – “within the basic categories of elements, additional variation and information can be added to support the requirements for complexity without dramatically changing the basic look and feel of the diagram”. From this statement it can be concluded that the idea of BPMN model refinement by adding special parameters to graphical elements to allow transformation between dimensions is not in conflict with BPMN specification. The second reason for proposing BPMN as official multidimensional modeling standard in this paper is the statement in BPMN specification [3] that describes a pool as the container for the sequence flow between activities, so a pool or a lane can be considered as a container for the flow of activities according to a particular dimension.

Table 2 describes how business process dimensions correlate with BPMN basic elements and what additional attributes must be defined to these elements in order to make transformation to each possible dimension.

**Table 2. BPMN correlation with dimensions**

Dimension name	BPMN element	Attributes
Performer dimension	Pools, lanes	Define the names of the pool and lanes.
Time dimension	Start event End event Intermediate event Task	Define process start time by adding time attribute to the start event. Define process end time by adding time attribute to the end event. Define the wait time before a particular activity can be initialized by adding time attribute to the intermediate event. Define the processing time of each activity by adding time attribute to the activity element. This time indicates the actual time spent for the activity.
Business rule dimension	Gateways	Define the condition for executing process flow by adding name attribute to the gateway element.
Information dimension	Data object	Define the name of the artifact by adding the name attribute to the artifact element.

#### 4 The requirements for the modeling tool

There are two basic preconditions for business process model transformation to another dimension, namely, the original business process model has to be constructed in the tool (1) with implemented dimension transformation feature and (2) compatible with BPMN version 1.1 standard. In this section the requirements for BPMN modeling tool are described to support dimension transformation functionality.

##### 4.1 Transformation to time dimension

To transform business process model from any dimension to time dimension it is required to define:

1. Start time of the process using BPMN start event element,
2. End time of the process using BPMN end event element,
3. Wait time before a particular activity can be started using BPMN intermediate event,
4. Processing time of each activity using BPMN activity task.

The time should be defined in a format dddd:hh:mm:ss (e.g. 0002:02:23:54, which means that activity is performed 2 days 2 hours 23 minutes and 54 seconds) [9]. The start and/or end time should be defined as a date and time.

BPMN 1.1 offers different types of activities, so processing time of the process activity must be defined according to its type:

1. if the activity is a looping task – then the processing time of one activity instance must be defined and then multiplied by loop counter,
2. if the activity is a multi-instance – then the processing time of one activity instance and the number of instances to be performed must be defined.

It should be possible for the user to define the granularity of the time dimension before transformation – in the result process activities are organized in the pools and lanes according to the defined time granularity:

1. by days – then the first lane contains activities that are performed from the process starting date to next day
2. by weeks – the tool organizes activities in the lanes by the weeks.

It should be possible to calculate the end time of each activity – it is an elementary mathematical task, hence the start date and time of the process is defined and the processing time of each activity is known. The tool should calculate the end time or the start time of the whole process by summing up the processing and wait times for all activities and adding the result to process start date or subtracting the result from process end time respectively.

The first step of transformation is to create the base of the model – the lanes named according to the time periods of time granularity chosen by users of the model. Then the tool organizes activities in the created lanes according to the defined processing and wait time of the activity.

## 4.2 Transformation to business rule dimension

Although BPMN does not provide any specific construct for specifying rules, they are usually represented through the gateway logic [1]. To transform business process model from any dimension to business rule dimension it is required to store the details about the business rule in the process as a set of attributes of a gateway element. The attributes defining business rules are:

1. name of the business rule – the user defines it as the name of a gateway,
2. input of the business rule – the tool automatically identifies input as the artifact associated with the input flow of the gateway,
3. possible outputs of the business rule – the tool automatically identifies the outputs as the artifacts of the gateways output flows,
4. condition of the business rule – the user has to define the condition statement in the gateway properties, which could be as the names of the outgoing gateway flows.

The first step in transformation is to create the base of the model – the lanes are named according to the names of the business rules. Then the tool organizes activities in created lanes according to activity's association with a particular business rule – whether activity's flow is an input or an output of the gateway controlling the process flow in compliance with the business rule.

## 4.3 Transformation to information dimension

In BPMN a data objects provide information about what the process does – how documents, data, and other objects are used and updated during the process [3]. The name “data object” may imply not only an electronic document, it can be used to represent many different types of objects, both electronic and physical ones [3]. In general, data objects are defined as inputs of the activity and as the outputs of the activity using the association as the type of connection to activity or to input or output flow.

In the business process the same data object can be an input for different activities – in this case BPMN specification [3] offers to connect this data object with all activities that this data is associated to using association. However, adding more connecting objects to the model can make it almost unreadable. Moreover, it can be time consuming to follow all the leads from one data object to every associated activity. The solution is to transform business process model to information dimension – to group activities in the swimlanes by the information they are using in their inputs or producing as their outputs.

To transform business process model from any dimension to information dimension it is required to define inputs and outputs of every activity in the process using data object elements. Data object elements can be associated with the sequence flow – in this case the tool has to be able to identify whether the data object is an input or an output of activity, or the data object can be associated directly to the activity using input or output associations [3]. The data object element has to be refined by adding the name of the object and the tool should generate the unique identifier of the data object – to differentiate data objects with the same names.

The first step of transformation is to create the base of the model – the lanes are named according to the names of data objects used in the process. Then the tool groups activities in created lanes according to activity's association with a particular data object taking into consideration whether data object is an input or an output of the activity.

## 4.4 Transformation to performer dimension

If the original business process model is created in other than performer dimension, then it should be possible for the user to define in the properties of the activity the name of the performer which is responsible for the execution of the activity.

The logic of the transformation to performer's dimension is described in previous sections – the tool groups activities in the created lanes by the performer.

## 5 Example of transformations

In this section a practical example of business process model transformation to time, business rules and information dimension is presented. The business process presented in this section defines the order of work for a testing team in the software development company. There are two roles in the testing team – the testing manager and the tester, each participant is responsible for carrying out a particular set of activities. The business process flow is controlled by four gateways, which are regarded in this article as business rules, and there are eight different artifacts produced and used by activities in the process.

Figure 1 describes the testing process from the performer's dimension – all process activities are grouped in the lanes by performer, lanes are organized in one common pool – Testing team. The process model contains the artifacts produced and used by activities, however the process model does not reveal any

information about time factor in the process – it is not defined when process is initiated and how long does it take for each activity to execute it. The time perspective of the business process is one of the crucial factors in the bottleneck analysis of the process. One of the possible solutions to represent the time factor in the model is to define the time within each activity as part of the activity name – e.g. “Prepare testing plan, 2 days”, however this solution does not prove itself useful when the modeler decides to present the process activities performed by weeks, days or months. Such representation of process activities could be possible without redrawing the process model in the tool with dimension transformation functionality.

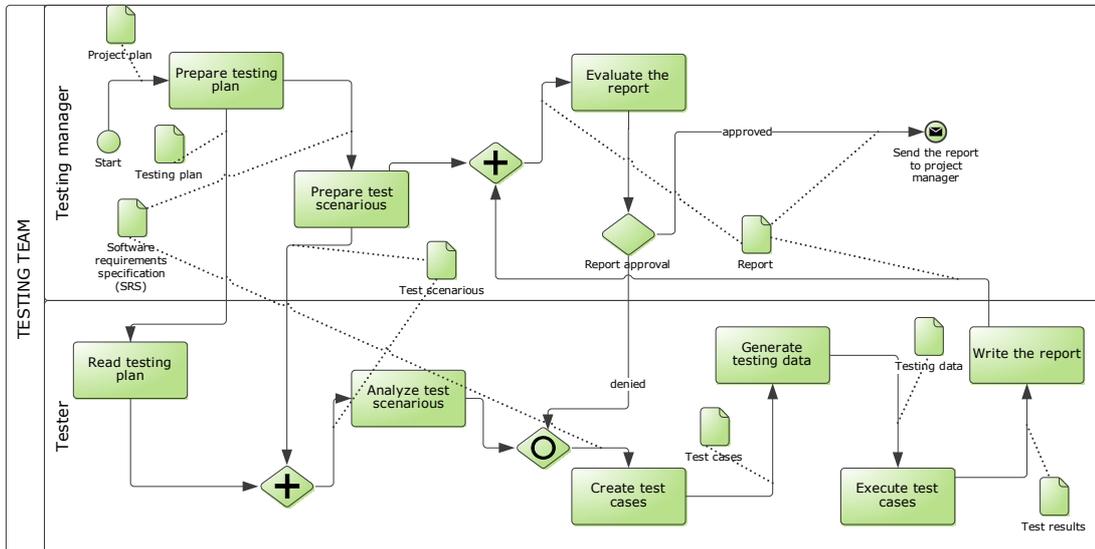


Figure 1. Business process according to the performer dimension

Figure 2 shows the draft of the process model with defined time dimension attributer after parameterizing BPMN process model elements. In this process model the start of the process is defined as a date, the processing time for each activity is defined in the “ddd:hh:mm:ss” format, the input flows show the start date of the activity, the output flows show the finish date of the activity.

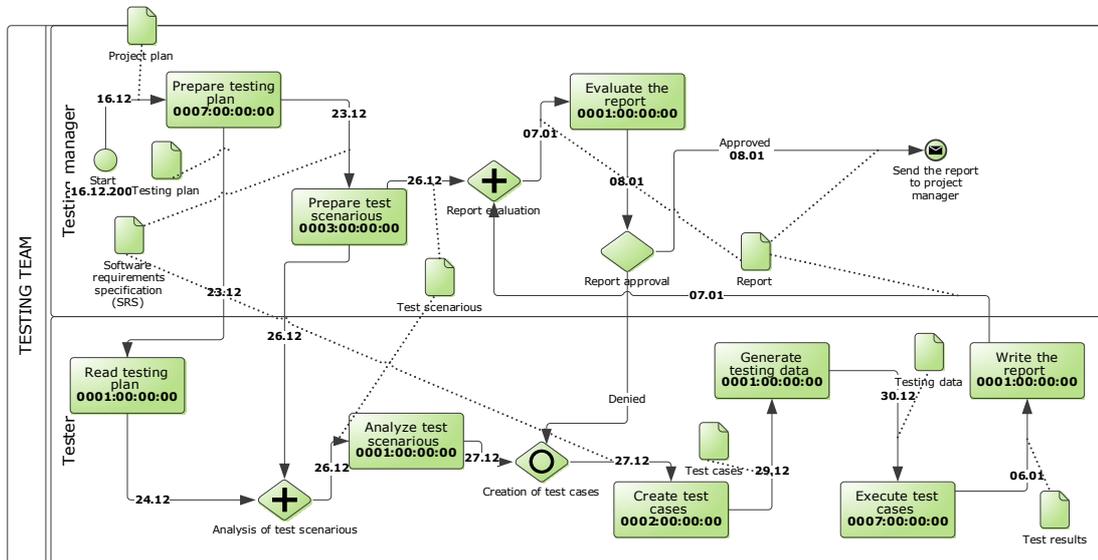
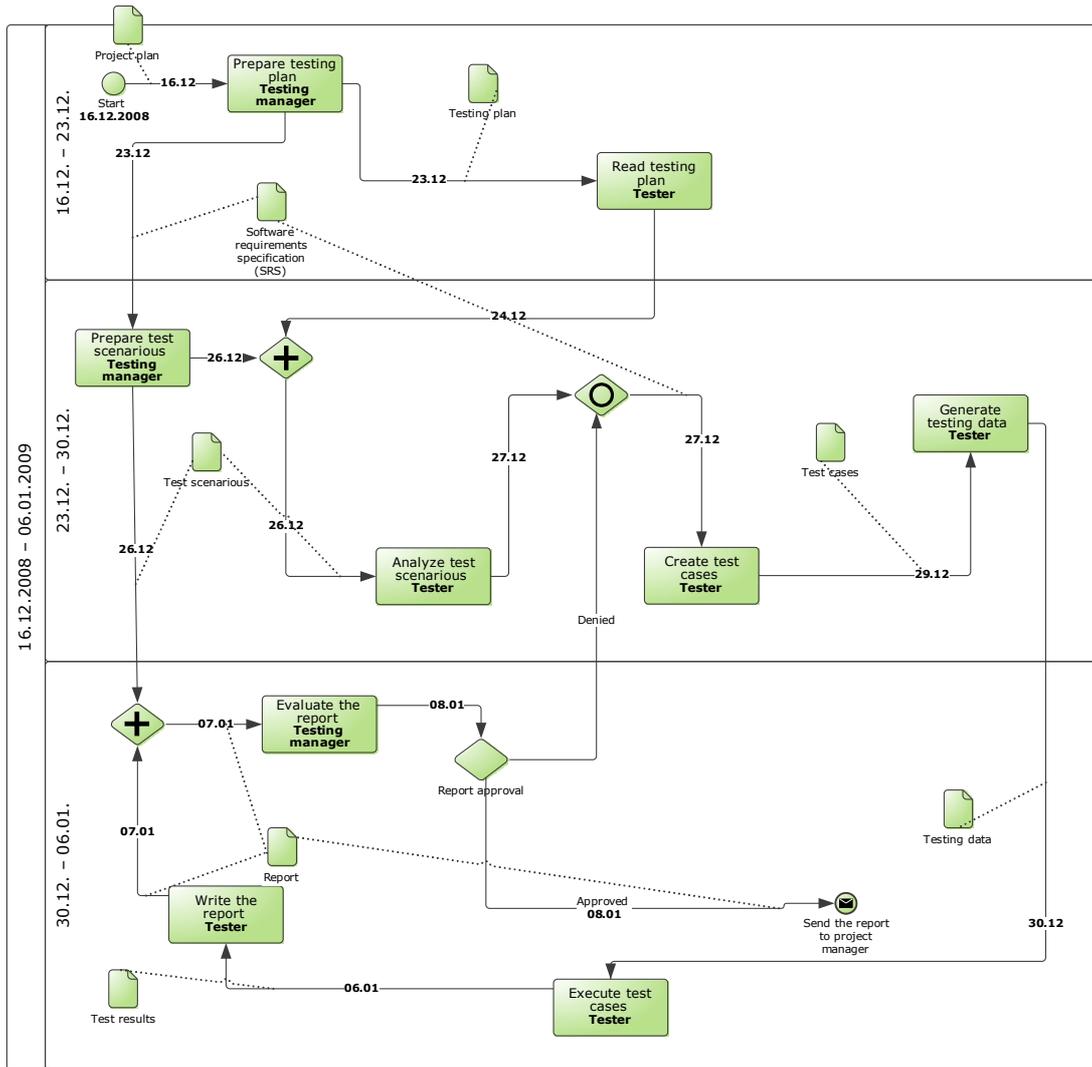


Figure 2. Business process according to the performer dimension with defined time attributes

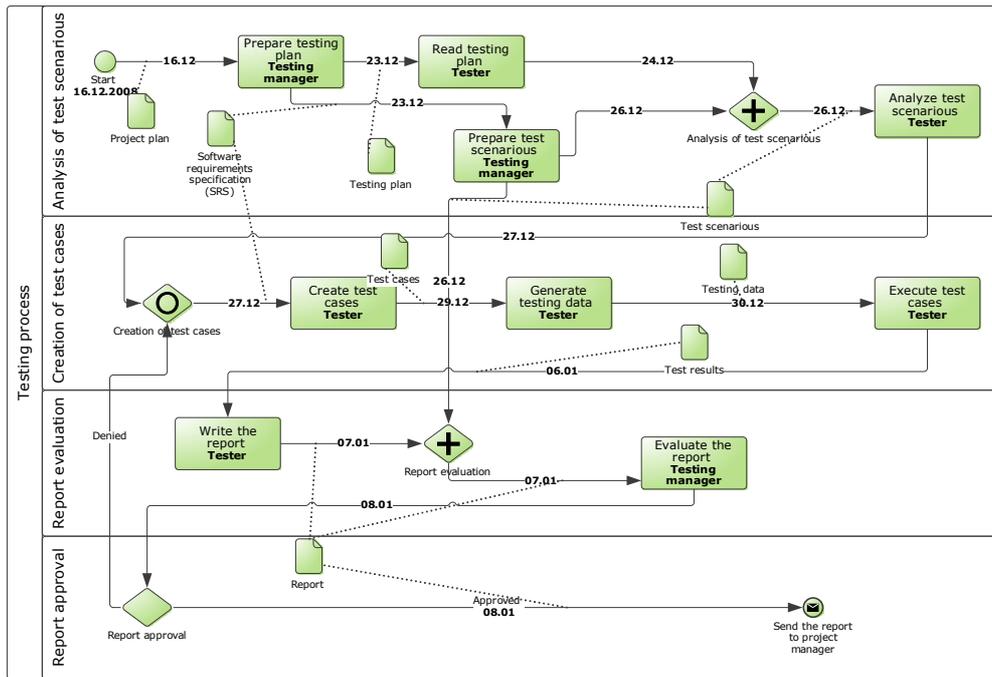
The process model in the figure reveals such important information about the time factor in the process – which process activity is the most time consuming, however the process model is still presented in the performer’s dimension. To present the process model in time dimension, the user of the modeling tool has to invoke the transformation function and choose the time granularity in order to organize process activities in the lanes according to time dimension. represents the process model in time dimension by weeks.



**Figure 3. Business process model according to the time dimension**

The important detail is to keep activity's performer name for process model enhancement. The model presented in organizes process activities by weeks and now it is obvious which set of activities are performed in the first, second or third week of the process.

represents the business process in business rules dimension – process activities are organized in the lanes by business rules.



**Figure 4. Business process model according to the business rules dimension**

Each lane contains one gateway or one business rule and activities which produce input for the gateway as well as activities which are initialized by business rule logic according to input data. The process model in business rules dimension presents which activities are affected by a particular business rule and what decisions are made during the process.

represents the business process in information dimension – process activities are organized by data objects that activities are using or producing. Overall there are 8 data objects used and produced in activities outputs, so the model in information dimension contains 8 lanes – each for one data object and contains activities to which data object is an input or an output. The business process representation in information dimensions shows by what set of activities a particular data object is used or produced.

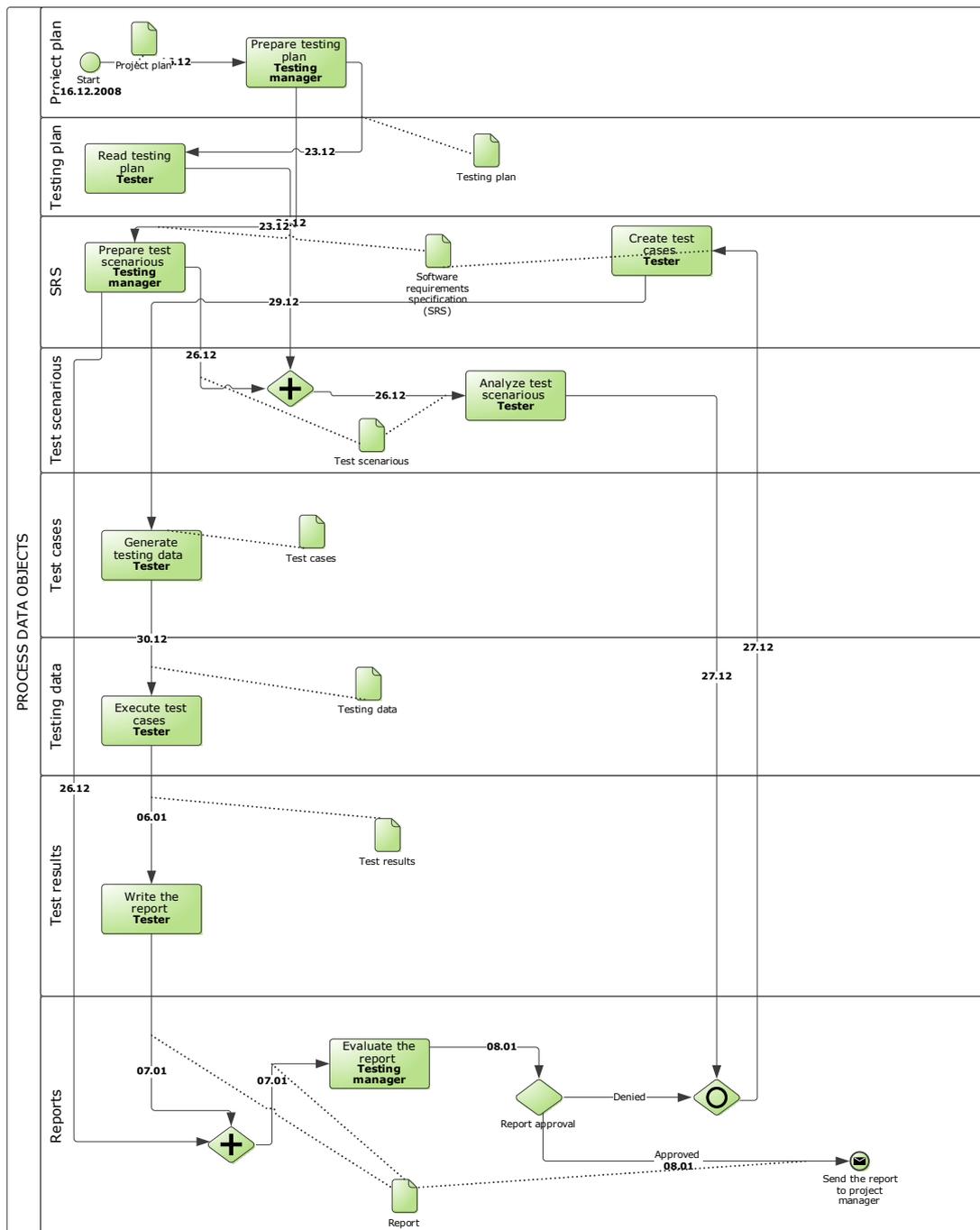


Figure 5. Business process model in the information dimension

## 6 Conclusions and future work

This paper introduces the foundations of business process multidimensional modeling using BPMN standard-based approach, a standard developed by the Object Management Group (OMG) [4]. A business process model is always modeled from a certain perspective of observation – e.g., time, business goals, performers, information and other perspectives [2]. Each perspective of observation may be regarded as a modeling dimension [2]. When observing business process model from certain dimension, the observer is getting all the details only from represented point of view – process activities are organized according to the certain dimension, however business process analyst has to view the process from different dimensions to discover bottlenecks and areas of potential improvement in a process, the most time consuming process activities and the process nodes that could be optimized. In this paper the following details of business process are regarded as business process modeling dimensions:

1. Performer dimension – represented in the business process model using lanes and pools

2. Time dimension – time dimensions attributes are defined in the attributes of BPMN events and activities
3. Business rule dimension – business rules are represented using BPMN gateways
4. Information dimension – information units produced and used in the process are represented using data objects

To represent business process from the most important dimensions, with the purpose to reveal all the relevant details about the process, the modeling tool with dimension transformation functionality is needed. The modeling tool with built-in dimension transformation functionality is a crucial point in multidimensional modeling – manual transformation may create syntax and semantic errors and is not time efficient.

As for the notation for multidimensional business process modeling the paper comes forward with BPMN business process modeling notation. In BPMN Lanes are used to organize and categorize activities within a pool. The meaning of the Lanes is up to the modeler – BPMN does not specify the usage of lanes [3] therefore lanes can be used for organizing process activities in different dimensions.

Transformations represented in this paper were quite simple and straight forward, mainly requiring only regrouping of the elements. In more complex cases more sophisticated changes in the models are needed to transform them from one dimensions to another. The future work will address these problems as well as code generation from multidimensional business process models.

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