TransCPEarlyWarning Civil Protection Early Warning Platform

TransCPEW Business Process Modeling MANUAL

"TRANSCPEARLYWARNING": Establishment of "TRANSnational Civil Protection EARLY WARNING System" to improve the resilience of Adrion territories to naturaland man-made risks.

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TRANSCPEARLYWARNING: Establishment of "TRANSnational Civil Protection EARLY WARNING System" to improve the resilience of Adrion territories to natural and man-made risks (ADRION 979)

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Contents

List of Figures

❖ Executive Summary

This manual focuses on the operation of process models which provide the necessary concepts and semantics for the envisaged Civil Protection Early Warning System Platform.

❖ Introduction

The **TransCPEW platform** aims to unify and automate the various Civil Protection (CP) processes regarding the prevention of natural and man-made disasters. **It serves the purpose of offering a focal point of reference for the Civil Protection stakeholders in ADRION territories** enabling the integration of different information sources and systems and will make it possible for CP stakeholders to perform the relevant experimentation through pilot implementations.

A Civil Protection Early Warning System essentially comprises a collection of processes in which information is exchanged between several actors in a predefined and organized fashion. The flow of information is time-dependent in most cases and involves several stakeholders with different responsibilities. Each stakeholder has a special reaction, dependent on the type of message he receives. It is obvious at this point that an EWS is a complex system that presents several challenges when trying to understand and integrate it into a web platform.

An extra degree of complexity is added when taking into account not just one but several different Early Warning Systems from the different partner countries. These countries have different organizational structures and follow different processes when dealing with the early warning part of a natural disaster. The number of involved actors can also vary greatly and the information flow does not always follow the same path.

Taking all the above into consideration, it is evident that the system has to be modelled in order to create a concrete base capturing the general principles behind the Early Warning Systems of the involved countries. An ontological model fits this purpose precisely, offering a formal specification of the terms in a specific domain and the relationships between them. The main goal of the model at hand is to support the sharing of a common understanding of the structure and flow of information of the EWS.

- The model attempts to answer to questions such as:
- What messages are created and exchanged in the system?
- Which stakeholders are involved in various steps of the process?
- What levels of administration the various stakeholders belong to?
- How does the information flow from level to level and to which direction?
- Are there any time related constraints in the process workflow?

The model answers these questions in a formal manner, easily reproducible and exchangeable between system agents and at the same it provides the basis for the implementation of a unified platform that can host the Early Warning Systems of all the partners. In order to achieve this, the system also answers another set of questions, such as:

- What are the differences among the actors involved in EWS of each country?
- How flow of information differs among countries?
- Are countries utilizing the same levels of administrative stakeholders in the process execution and information flow?

The TransCPEW model is a result of analysis of the different concepts implemented by the Civil Protection Early Warning processes and systems in the different countries. This model has been designed to be applicable in the area as a whole.

The current document, "TransCPEW Business Process Modeling MANUAL", addresses experts authorized for designing or transforming existing Business Processes.

1. Background Knowledge

1.1. What is a model

In order to create a model of the real world, we can adopt the meaning triangle from semiotics as depicted in the following figure. The left part depicts the meaning triangle for an individual, whilst the right one for a specific domain.

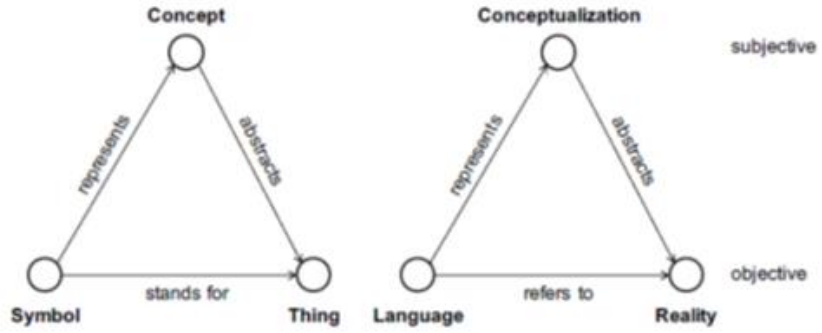


Figure 1: The meaning triangle for and individual (left) and for a specific domain (right)

The triangle on the left consists of three vertices:

- The ***symbol*** or *sign*, which is the representation of an object and is used to help us express our concepts
- The ***thing*** or the *object*, which is something that can be observed and identified. It can be either concrete or abstract.
- The ***concept*** is a subjective thought in our mind.

The set of all the concepts and the relations among them that are extracted from a specific domain is called the ***Conceptualization***. In order to express the overall conceptualization, we need a language (right triangle). A conceptualization that can, among others, model a system, provides a particular view of reality that serves a specified purpose.

Systems can be described like objects that have the following properties:

- a ***composition***: a set of elements of some kind,
- an **environment**: a set of elements of the same kind,
- a ***structure***: a set of influence bonds between the elements in the composition and between the elements in the compositions and in the environment.

The concept of production, the production of goods or services from the elements of the composition and the delivery to the elements of the environment, was added by Dietz. According to Dietz, three

categories of systems can be identified i) concrete systems, ii) conceptual systems, and iii) symbolic systems.

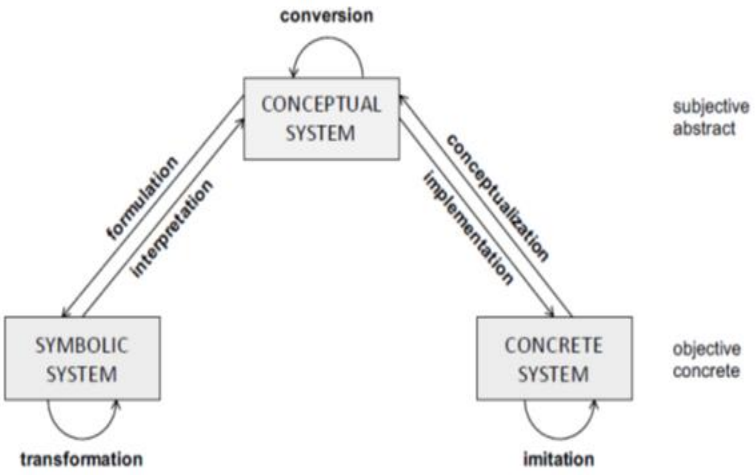


Figure 2: The model triangle

The conceptualization of a concrete system is a conceptual system (Figure 2), while the implementation of a conceptual system is a concrete system. A symbolic system is represented with the use of some formal language or notation. Finally, a conceptual model of a symbolic system is called an interpretation of the system.

1.2. Model requirements

REQ01: describe the CP processes, actors and actions with description languages

The processes, the actors and the actions have to be described in a formal manner that would guarantee the clear definition of the participating entities and the interactions between them in a way that would ensure the implementation of the model on the Early Warning System Platform (EWSP).

REQ02: enable the adaptability of the implementation to different scenarios or business processes associated with civil protection

The model should fit and adapt to different use cases and scenarios of Civil Protection processes.

REQ03: ensure the consistency of the data processed by the system

The model should satisfy properties of consistency (i.e., non-contradictory relations among entities) and data integrity (during operations like transfer, storage or retrieval data are maintained identical).

1.3. Knowledge Modeling Primitives

Each Knowledge representation technique includes the appropriate tools in terms of modelling primitives to formalize domain knowledge. Such primitives may be classes, relation, attributes, etc. In

the section below, the knowledge modelling components per knowledge representation (KR) technique are presented.

First order logic and frames KR techniques

Six different kinds of primitives are utilized in order to model knowledge ontologies using first order logic and frames. More specifically these primitives are:

- Classes: they represent either concrete or abstract concepts.
- Relations: they represent types of connections between concepts in a particular domain. In most cases, these connections model binary relations where the first argument is the domain of the relation and the second is the range. Inheritance relations are most often used to organize taxonomies.
- Classes may have attributes. There is a difference between attributes and relations since the range of attributes is a data type and the range of a relation is a concept.
- Functions: they constitute a special case of relations.
- Formal Axioms: the model cases or sentences that are always true. They are used as building blocks for inferring new knowledge.
- Instances: they represent elements or individuals.

KR techniques in Description Logic

Description logic (DL) can be divided into two categories, the TBox and the ABox. In the TBox, all the definitions of concepts and roles are included, while in the ABox are included the instances. There are three kinds of entities that are used to model ontologies using description logic:

- Concepts: in the context of DL they represent classes of objects. They can be either primitive (include only the necessary conditions for the individual) or defined (include necessary and sufficient conditions that have to be met by the individual).
- Roles: they are used to represent binary conditions between the concepts and properties of the concepts. In addition, special types of relations can be utilized to represent functions in DL.
- Individuals: they represent instances of concepts and their properties, meaning the values of their roles.

It must be noted that formal axioms in DL are included in concepts or roles.

KR techniques in Software Engineering

Unified Modeling Language (UML) can be used for modeling ontologies. It is a very popular modeling tool amongst engineers, has a standard graphical representation and is supported by a wide variety of available development tools and environments.

In UML diagrams, classes are represented by boxes with three separate parts. The first part contains the name of the class, the second contains the attributes of the class and the third part the operations of the class. However, operations are not used in ontologies. There is no difference between class and instance attributes. The cardinalities of each attribute are represented using the (Object Constraint Language) OCL and are attached as notes.

Relevant instances are connected to classes via dashed arrows while aggregation of classes is depicted by diamond head arrows. Associations, which are binary relations between classes, are specified via solid arrows and can be restricted by the relevant cardinalities. Extra classes have to be created for the representation of higher arity relations.

1.4. Process Modeling

Process models represent processes of the same nature that can be grouped into a model. As described in the previous chapters, a process is the implementation of the process model and, vice versa, the process model is how the process is anticipated to be executed. The goals of a process model are:

- Descriptive
  - Monitor and tracking of the actual process.
  - Provide the appropriate view to an external observer for determining the improvements that have to be made.
- Prescriptive
  - Definition of the processes and the way they could be implemented.
  - Establishment of a set of rules, guidelines and design patterns that would lead to the desired process performance.
- Explanatory
  - Provision of the appropriate explanations about the process.
  - Exploration and evaluation of the different possible courses of action based on rational arguments.
  - Establishment of a connection between the processes and the requirements that the process has to fulfill.
  - Definition of points where reporting data can be extracted.

If the domain of the processes is an enterprise/organization, the processes are called *business processes* and accordingly the act of modeling is called business process modeling. There are three types of business processes:

- **Management** processes that define the governance of the organization.
- **Operational** processes that include the core business process which add value to produced product or service.
- **Supporting** processes that support the operational processes.

2. Business Process Management

2.1. Definition

According to Workflow Management Coalition[1] *"a Business Process Management (BPM) is a discipline involving any combination of modeling, automation, execution, control, measurement, and optimization of business activity flows, in support of enterprise goals, spanning systems, employees, customers and partners within and beyond the enterprise boundaries."*

It differs from program management in the sense that program management is focused on the management of a collection of interconnected projects. Process management, on the other hand, encompasses program management. Project management is the use of repeatable processes to improve the project's outcome in project management.

[1] Hollingsworth, David, and U. K. Hampshire. "Workflow management coalition: The workflow reference model." *Document Number TC00-1003* 19.16 (1995): 224.

Repeatability and predictability are significant differences between process and project management. When there is a unique structure and sequence of tasks, we deal with project management. A sequence of tasks in business process management might vary from instance to instance: there are gateways, conditions, business rules, and so on. Processes are key assets of a business that must be understood, controlled, and improved in order to advertise and provide value-added products and services to clients or consumers, according to the BPM methodology. Other comprehensive quality management or continuous improvement process approaches are similar to this approach.

2.1.1. BPM Lifecycle

Design

The identification of existing processes as well as the design of "to-be" processes are both covered by process design. The process flow, the components within it, alerts and notifications, escalations, standard operating procedures, service level agreements, and task hand-over methods are all areas of concern. Whether or not current processes are considered, the goal of this stage is to guarantee that the modern design is correct and efficient.

The proposed enhancement could be in human-to-human, human-to-system, or system-to-system workflows, and it could be aimed at addressing regulatory, market, or competitive concerns. Existing processes and the development of a new one for a variety of applications must be aligned and should not produce a major outage or process interruption.

Modeling

Modeling incorporates variables (e.g. changes in rent or materials costs, which determine how the process might operate under different circumstances) into the theoretical design. It may also entail performing "what-if analysis" on the processes (e.g. Conditions-when, if, else).

Execution

Enacting a discovered and modeled business process is what business process execution is all about. A business process can be carried out manually, automatically, or through a combination of manual and automated business tasks. Manual business processes are driven by people. Business processes that have been automated are software driven. Business process automation refers to the methods and software used to automate business processes.

The business process layer or the consumer presentation layer of the SOA Reference Architecture is where business process automation is done and orchestrated. At the business process layer, BPM software suites such as Camunda or iBPMS, as well as low-code platforms, are used. While the emerging robotic process automation software performs business process automation at the presentation layer, therefore is considered non-invasive to and de-coupled from existing application systems.

The development or acquisition of an application that executes the needed steps of the process is one technique to automate processes; but, in practice, these programs rarely execute all the phases of the process precisely or entirely. Another option is to combine software and human participation; however, this strategy is more complicated, making the documentation process more challenging.

Companies have developed software that expresses the entire business process (as defined in the process design activity) in a computer language that a computer can immediately execute in response

to these issues. Process models can be operated using execution engines that automate operations straight from the model (for example, creating a loan repayment plan) or through Business Process Modeling Notation (BPMN), which gives front-end capacity for human input when a step is too difficult to automate. Directly running a process specification, as opposed to either of the previous ways, can be more straightforward and hence easier to change. Automating a process definition, on the other hand, necessitates a flexible and extensive infrastructure, which often precludes the use of these solutions in a legacy IT environment.

Systems have employed business rules to define controlling behavior, and a business rule engine can be used to automate process execution and resolution.

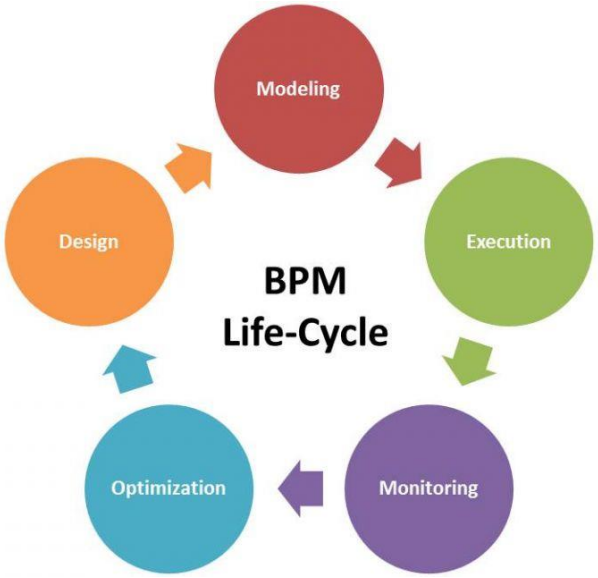


Figure 3: BPM Lifecycle

Monitoring

Monitoring entails tracking individual processes so that information on their status and statistics on the performance of one or more processes can be readily available. Being able to know the status of a customer's order (e.g. order received, pending delivery, invoice paid) so that faults in its functioning can be identified and remedied is an example of this tracking.

This data can also be utilized to collaborate with customers and suppliers to improve their interconnected operations. Measures such as how quickly a customer order is processed or how many orders were completed in the previous month are examples. Cycle time, defect rate, and productivity are three of the most used metrics.

The degree of monitoring is determined by the type of data the company wants to assess and analyze, as well as how it wants it monitored: real-time, near real-time, or ad hoc. Business activity monitoring (BAM) is a tool that complements and increases the monitoring features provided by BPMS.

Process mining is a set of methods and tools for monitoring processes. Process mining is the process of analyzing event logs obtained through process monitoring and comparing them to a priori process models. Process mining allows analysts to spot inconsistencies between real process execution and the a priori model, as well as identify bottlenecks.

Data mining, machine learning, and other forecasting techniques are used in predictive business process monitoring to predict what will happen with running instances of a business process, allowing

estimates of future cycle time, compliance issues, and so on. Support Vector Machines, Deep Learning methods, and Random Forest are examples of techniques for predictive business process monitoring.

Optimization

Process optimization entails obtaining process performance data from the modeling or monitoring phases, identifying prospective or real bottlenecks, as well as potential cost-cutting or other improvement opportunities, and then incorporating those upgrades into the process design. Process mining technologies can identify essential operations and bottlenecks, resulting in increased business value.

2.2. BPM Suites

Enterprise software that uses business process management concepts to organize and automate activities has grown considerably as a market over the last several years. Integrated Business Process Management Suites have emerged because of the recent convergence of this software from disparate components such as business rules engines, business process modeling, business activity monitoring, and Human Workflow. BPM suites can be categorized in the following categories according to different perspectives:

- BPM with a human focus and
- BPM with a focus on integration (Enterprise Service Bus)
- BPM that focuses on documents (Dynamic Case Management)

BPM is now widely regarded as a key component of operational intelligence (OI) solutions for delivering real-time, actionable data. This real-time data can be used in a variety of ways, such as sending warnings or using real-time dashboards to make executive decisions. OI systems use real-time data to automate actions based on pre-defined criteria, allowing for the implementation of security measures and/or exception handling processes.

A BPM Suite consists of four essential components:

- Process engine — a powerful platform for designing and running process-based applications, including business rules.
- Business analytics enables managers to use reports and dashboards to discover and react to business concerns, trends, and opportunities.
- Content management is a method of storing and protecting electronic papers, photos, and other assets.
- Collaboration tools — use discussion forums, dynamic workspaces, and message boards to break down intra- and inter-departmental communication barriers.

Many of the essential IT concerns that underpin these business drivers are also addressed by BPM, including:

- Managing customer-facing processes from beginning to end
- Increasing visibility and access to related data and information by consolidating data
- Increasing the data and infrastructure's flexibility and functionality
- Using service-oriented design and integrating with current systems (SOA)
- Creating a shared language for business-IT collaboration.

2.3. BPM Benefits

Increased productivity

BPM aids in the creation of robust frameworks for all the organization's processes. All critical processes are documented, tracked, and improved. Process efficiency improves when processes run smoothly and with minimal disruptions. Process analysis is done on a regular basis. Tasks that are of no value are quickly discovered and eliminated, resulting in a boost in total productivity.

Agility

Teams are more adaptable to changes when BPM is properly implemented in a business. Teams are well-versed in their processes and why they work the way they do. Explaining why and how a new change to teams is simple when processes are well understood. Because the process roadmap is explicit, course correction is easier. Any adjustments may be rapidly identified and implemented. A powerful organization is one that is adaptable to change. It can solve any problems that arise because of internal or external forces, resulting in exponentially higher results. Scalable, competitive, and collaborative teams emerge.

Reduced Errors

Errors are almost unavoidable with primitive technologies like spreadsheets and emails. There is no way to keep track of who does what and when data is updated. When processes are controlled in spreadsheets, it is also impossible to track errors. When there are no stakeholders for each step in a process, errors are common. The probability of errors is considerably minimized with good BPM practice. Each step's stakeholders are educated of their responsibilities and must ensure that they meet the established requirements. Errors can simply be tracked back to their source if they occur.

Ensured policy compliance

BPM is a one-time solution for streamlining operations and establishing a framework that complies with all internal and external policies. BPM ensures that processes are well-understood and adhere to stringent rules. There are a slew of industry and departmental policies to follow. Procurement and HR, for example, have completely distinct internal policies to follow. Both teams should be able to comply with their separate policies in the same tool using a BPM tool.

Reduced micromanagement

Micromanagement could be able to get the work done right initially. However, in the long run, it is always detrimental to a business. One of the main reasons why executives micromanage their staff is to reduce errors by sticking to their methods. Micromanagement is no longer necessary thanks to BPM. All standard operating procedures are carefully recorded by the executives, and staff are well-informed about their responsibilities. When it is time for a certain step, employees complete it without assistance or instructions every time.

Controlled data accessibility

Employees require access to data from several sources to function effectively. But that does not imply they must have access to everything. Allowing access to superfluous data leads to confusion and delays. The best technique for establishing a balance between data overload and inadequacy is business process management (BPM). You can restrict access to data that is essential to complete a task and choose to hide the rest.

Company-wide platform

The correct BPM tool can serve as a central platform for retrieving and pushing data to different software systems like a CRM. Department-specific software is typically created for specific use cases. It can be tough to get data and use it for other purposes. The benefits of integrating core software with a company-wide BPM platform are numerous. Some processes require human interaction, while others do not. By automating operations, you may reduce manual data entry and cycle time. Everyone has access to the company's key operations and can access information in many systems at the right level.

Digital Transformation

The term "digital transformation" is no longer a novelty. Using digital technologies and techniques to deliver organizational stability and adaptability is a key component of digital transformation. It is critical to use no-code BPM systems in the digital transformation activities.

3. Business Process Model and Notation (BPMN)

3.1. BPMN elements

The Business Process Model and Notation (BPMN) is the de facto industry standard concerning the techniques for depicting business process models and is maintained by the Object Management Group (OMG). It provides a graphical notation for specifying business processes in a Business Process Diagram based on a flowcharting technique very similar to activity diagrams from Unified Modeling Language (UML). Its main objective is to provide a notation scheme comprehensible to both business and technical users. In addition, one of the major advantages of this standard is that it can serialize the visual models into computer readable formats, like XML. The process models can also be constructed in XML without the need of the visual model.

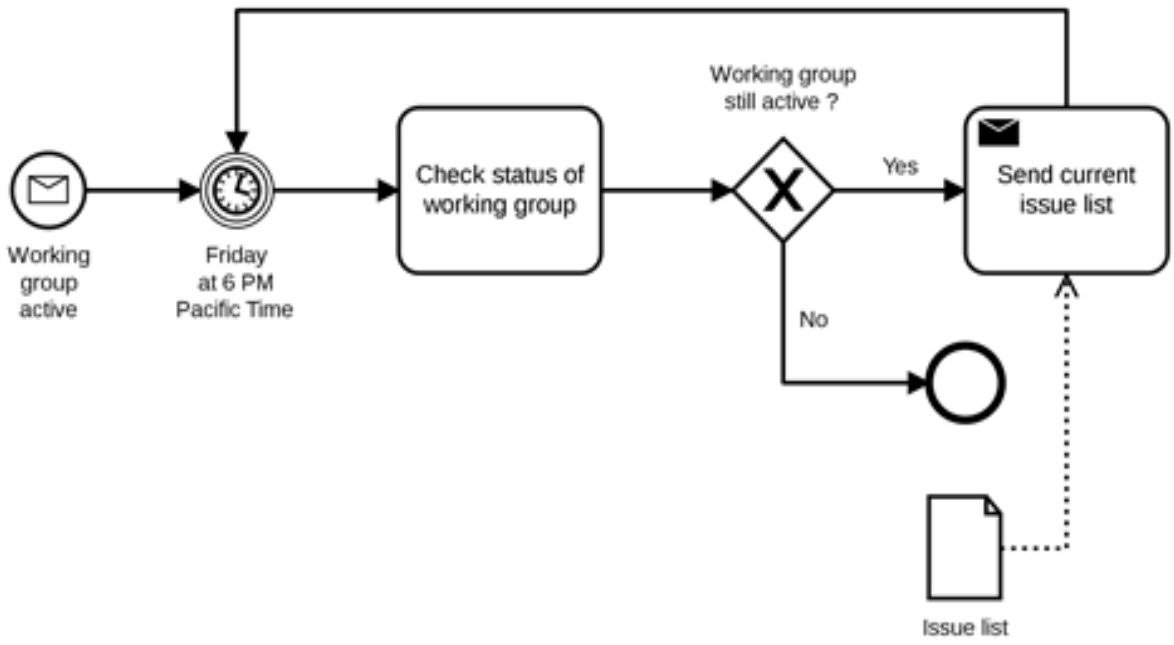


Figure 4: A BPMN process model

BPMN includes four different types of elements:

- Flow objects: they include events, activities, and gateways.
- Connection Objects: they include sequence flows, message flows, and associations.
- Swim lanes: they include pools and lanes.
- Artifacts: they include data objects, groups, and annotations.

Below, we present the individual elements of each of the four types in more detail.

Events

An Event is a trigger that starts (start event), completes (end event) or modifies (intermediate event) a process and denotes something that happens. Events are represented with circles containing other notations, depending on the event type. They may include timer, error, message, signal, cancel, link escalation, custom action, etc. They are also classified as catching (e.g. the incoming daily fire risk map) and throwing (e.g. the completion of a sub task).

Activity

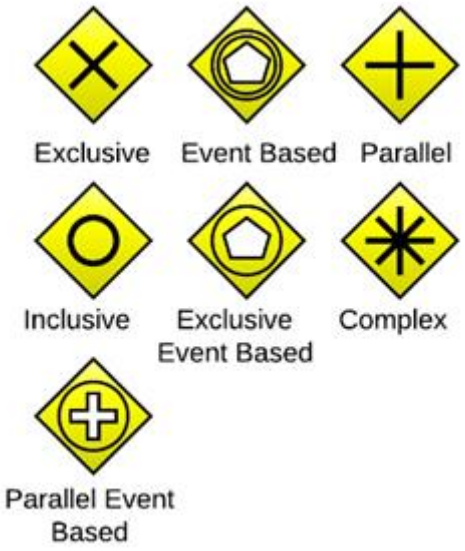
Activities are represented with rounded-corner rectangles and describe the kind of work that has to be done. It can be either atomic or compound.

A task activity is a type of activity that cannot be broken down to further business processes. A sub-process is a compound activity and is used to conceal business process details. A transaction is a sub-process in which all contained activities must be treated as a whole. Finally, the call activity is a task that reuses an existing a global activity or global task.

Gateway

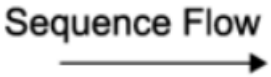
It is represented with a diamond and signals the forking and merging of paths depending on the examined condition. The following types of gateway can be defined:

- Exclusive: it creates alternative paths in the process but only one of the paths can be followed.
- Event based: the condition examined is based on the evaluation of an event.
- Parallel: it creates parallel paths without any condition.
- Inclusive: it creates alternative flows where all paths are evaluated
- Exclusive Event based: same as the exclusive but the evaluation criterion is an event.
- Complex: it models complex synchronization behaviors.
- Parallel Event Based: an event, without evaluation, triggers two parallel paths.



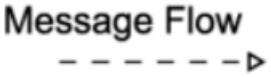
Sequence Flow

It shows the order of activities to be performed. It is depicted as a straight line with an arrow.



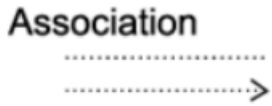
Message Flow

It represents messages that move along pools or distinct organizations such as departments. It is depicted as a dashed line with a circle at the start and an arrow at the end.



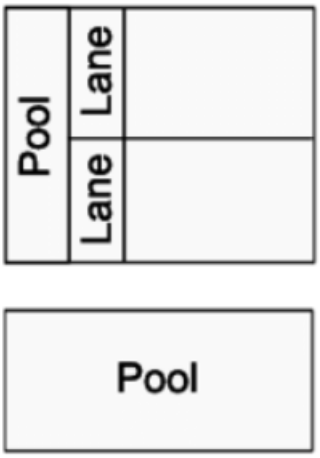
Association

It is represented with a dotted line and links an artifact or text to an event, activity or gateway.



Pool and swimlane

A pool depicts major actors of a process. Pools may not be in the same department or company. Swimlanes are parts of a pool and define the activities and flows for certain participants.



Artifact

Artifacts are used for storing additional information that the developer needs to store in the diagram. There are three types of artifact:

- Data objects depict data necessary for the activity.
- Groups logically combine activities but don't change the flow.
- Annotations provide additional information to the diagram.