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**Hybrid Business Process Modeling**

Projeto de Dissertação

Mestrado em Engenharia e Gestão de Sistemas de Informação

Trabalho efetuado sob a orientação do

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Fevereiro de 2018
Abstract

The current situation of the business world is in a stage of great competitiveness and this leads current organizations to come up with some kind of strategy that can maintain them in its prowl. They then create and implement mechanisms that quickly and successfully promote the development and optimization of their Information Systems. The more agility and updated an organization is, the more distinction it can be from the other companies. This factor is the most important advantage in giving response in a timely manner to the market pressures, needs and opportunities.

This leads organizations to focus on their business processes to present high levels of competitiveness and realize that these processes can be a main factor for their success. But because this isn’t an easy task, organizations manage their approach through a set of organized activities, to ensure greater control, flexibility and ability to align organizational processes with organizational strategy. One of these activities in this approach is the hybrid process modeling, that has the ability to define and change organizational processes in a more reflected and structured way and also the ability to make them much more simple and easy to make and understand.

This work intends to deepen the knowledge about process modeling and to perform a lithographic review on the various languages of business process modeling, such as BPMN, CMMN and DMN. It is also intended to make a study on how best to combine all these languages to produce an effective and perceptible process modeling.
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1. Introduction

This first chapter will present the problem statement, that includes the motivation for the project realization. Then it will be explained the objectives and the expected outcomes. Finally, the last point being approached will be the document structure with the reference to the chapters studied in the project.

1.1 Problem Statement

BPMN is an important language for the modeling of business processes. It has a great capacity to represent the most procedural parts of any process, that is, tasks that are repetitive or consistent, they are typically suited to business processes characterized by some stability, where the threads and sequences of activities and decisions can be predefined. Its use has been growing day by day due to the need of business studies.

However, this type of language is already less appropriate in situations of greater variability, in which the execution logic needs to be more flexible. For these situations a less procedural and more declarative approach to process modeling would certainly be more appropriate. Compared to procedural process modeling approaches that tend to produce "closed" models, declarative process modeling approaches produce "open" models, and languages such as CMMN and DMN came to complement it with the ability to operate at that level.

Often, in the same business process, there are procedural parts with declarative parts. It is in this context, complementing the BPMN, adequate to the most procedural parts of the processes, that the CMMN proposal is introduced, by being capable of translating much of the flexibility and adaptability required by the more declarative parties, along with the DMN, capable of representing complex business decisions embodied in the BPMN and CMMN models.

Thus, in this work the hybridization of the three languages will be explored to model a passive business process of having all kinds of elements, procedural or flexible, that exist in organizations, exploring the modeling of processes using the conjugation of those three languages.

1.2 Objectives and Expected Outcomes

As we know BPMN (Business Process Model and Notation), currently in its version 2.0. It is considered the standard in terms of organizational process modeling. However, several other modeling languages appeared to complement and support it.

This work has as main objective the modeling of a sufficiently representative hybrid business process, that integrates the languages BPMN, CMMN and DMN. This will require knowledge of business process modeling and the systematization of the current state of BPMN, CMMN and DMN languages.
The expected outcomes of this project are the verification of the possible coordination and compatibility of the three languages, the effectiveness of that hybrid modulation and the advantages it would bring to any organization that would be willing to implement it.

1.3 Document Structure

This document is structured in six chapters.

In this chapter is presented a contextualization of the origin and necessity of the dissertation and investigation realization. Also, a description of the main objectives and expected results of this project.

The second chapter approaches the Business Process Management theme. There is a definition and a presentation of its introduction to the organizational world. A brief passage to its life cycle is studied, because in the future of this project it will be needed for guidance during the process of modeling a business process. There is also an introduction of Business Process Management Systems and what they need to accomplish to be a successful choice. Finally, a brief presentation of business process is explored to give context and connection to the next chapter.

The third chapter presents Process modeling and all three modeling languages BPMN, CMMN and DMN. Within each one it there is an introduction, the elements that constitute them and a small example of how it functions with a small explanation. There is also a demonstration of a business process that utilizes all the three languages together with a explanation of how its conducted.

In fourth chapter the methodological approach used to develop the research project is defined and justified, in this case Design Science Research.

The fifth chapter the planning and schedule of the main activities that cover the entire realization of the research project are introduced.

The final chapter presents some final considerations related to the efforts in this preliminary phase of the research project.
2. Business Process Management

BPM is all about continuous business process improvement and it has two important roles, that are the process identification, that represent the activities and their elements, and the representation of new processes, for performance evaluation. It can be seen as a set of methods and competences, or as an approach that through a relation between management and information technology tries to find and define the best and most reliable process for a certain organization and to improve the optimization on already existing ones (Magalhães, 2008).

It is a discipline that involves any combination between modeling, automation, execution, control, measurement and optimization of business activity flows, to support enterprise goals, spanning systems, employees, customers and partners within and out of the boundaries of the organization. The result of methods, techniques and tools has then to support the design, enactment, management, and analysis of operational business processes.

It is also based on a continuous improvement cycle with the objective of enhancing the strategic alignment regarding the market and the clients. This will bring a competitive advantage, as like the differentiation between products or services. So, the organizations that that constantly seek their process improvement allow an easier integration of the new processes.

So, in a more briefly matter, we can say that BPM comes from two different areas, that are management and information technology and results in a set of methods, techniques and tools for the design, interaction, control and operational analysis of business processes, involving people, organizations applications, documents and other sources of information (Oliveira, 2008; van der Aalst, 2013).

2.1 Business Process Management Introduction

Organizations are interested in understanding, managing and improving their business processes and the set of tools and methods to achieve all these goals is known as BPM.

In recent times BPM has been getting a lot of investigation and development interest, manly for its ability and potential of productivity improvement and organizational cost reduction, guarantying sustainability (van der Aalst, 2013). Currently there is already several BPM systems on the market capable of manage and control organizational business process.

This is an expanding area in the organizational world for the guarantee of improvement in organizational processes of the organizations. It is a way to add value to their business, since it is expected that with a well-organized organizational process there is an identification of activities that should or should not be performed and this gives an improvement on resources, time and costs (Andrade, 2016).

Due to increasing levels of organizational competition and a competitive market, organizations needed to adapt to all the changes that were taking place around them. This capacity was not supported by traditional organizational structures, since these are oriented to functional and hierarchical segmentation, so they represent obstacles to the adaptation that they are exposed.
The main point of BPM is to align business process with client needs and strategic objectives, so it makes the organization change its functional orientation to a process orientation.

When successfully implemented BPM integrates and transforms the culture of the organization, adjusting how the business is conducted. It can be applied to any type and dimensions of organizations, with the primary objective of redirecting the organizational resources.

BPM requires the participation of all the organization, from administration to operational level and everything in between. It reveals a new vision beyond the traditional and functional structures about the business operations. It evolves all the executed work for the delivery of the product or service, no matter what functional areas or locations are involved.

It represents the organizations as a set of linked processes with the objective of accomplishing their proposed services or products. So, the organization politics are still determined on the high hierarchy levels, but the functional work teams are the ones responsible for controlling and redefine the work methods (Davenport, 1992).

In BPM the concept of a process model is fundamental. Process models can be used to configure information systems, but also be used to analyze, understand, and improve the processes they describe. So, by that we have the introduction of BPM technology to the organizations, that has both management and technical ramifications and can provide significant productivity improvements, cost savings, and flow-time reductions.

So, at this point organizations started to adopt business process, that allow them to have a global and integrated view of work, which allows them an ability to adapt in a quicker and faster way to the constant demands they face.

To cope with all these high competitive levels in the organizational world, organizations created a new paradigm where BPM appears as one of the fundamental pillars (Hammer & Champy, 2006; Verner, 2004).

2.2 BPM Life Cycle

Is a discipline that uses various methods to discover, model, analyze, measure, improve, and optimize business processes.

To manage organizational business processes, there are a group of activities that need to be performed. These activities are a part of the process management lifecycle.

Initially is intended to design the process configuration, that is, defining the process activities and tasks, the human and technologic resources to perform those activities, conditions and circumstances.

The design of the business process should be documented using a notation as a purely formal step. Although there are many different process management lifecycles for management and improvement of business processes, the essential BPM lifecycle is demonstrated ahead.

Once a process is in place, it has the necessity to be continually managed. The performance, in terms of critical metrics that are associated to customer needs and company requirements, need to be compared to the targets that were proposed to be meet and if performance does not achieve the expected, the reasons for the flaw must be determined. Once the intervention has
been chosen and implemented, the results need to be assessed and the cycle begins again from the start. This cycle of process improvement repeats continuously for as long as process exists. This introduces continual process improvement into organizations in a structured and easy to use way (Morais, Kazan, Pádua, & Costa, 2014; van der Aalst, 2013).

![BPM Life Cycle](image)

**Figure 1 - BPM Life Cycle**

The steps in a BPM Life Cycle (Figure 1) are:

- Process Identification;
- Process Discovery;
- Process Analysis;
- Process Redesign;
- Process Implementation;
- Process Monitoring and Controlling.

**Process Identification**

It captures the business processes at a high level and gathers enough detail to understand conceptually of how the process works.

It identifies an organization’s business process and prioritizes their management based on certain criteria, with the objective of getting a broad picture of processes in the organization and to maximize the value of BPM initiatives (Morais et al., 2014).
Process Discovery

Mostly composed by four steps (Morais et al., 2014):

- Defining the setting that is dedicated to assembling a team in a company that will be responsible for working on the process;
- Gathering information concerning with building an understanding of the process. Different discovery methods can be used to acquire information on a process;
- Conducting the modeling task, in that it deals with organizing the creation of the process model. The modeling method gives guidance for mapping out the process in a systematic way;
- Assuring process model quality that aims to guarantee that the resulting process models meet different quality criteria. This phase is important for establishing trust in the process model.

Process Analysis

Is the act of conducting a thorough review and arriving at a complete or portion understanding of a business process, with the goal of maintaining or achieving process excellence, or achieving incremental to transformational improvements in a business process.

Process analysis involves looking at all components of a process, could they be inputs, outputs, mechanisms and controls, inspecting each component individually and as they interact to deliver results. These components can often be categorized into people, processes, applications, data, and technology needed to support a business goal or objective. Analyses cover and uncover quality, time, and costs at all points of a business process, from inception to completion.

Aids to process analysis can include:

- Visual process models, both static and dynamic;
- Data collected at the beginning, duration, and end of key activities, lower level processes, and the entire business process itself;
- Business process analysis methods such as value chain analysis, end-to-end modeling, and functional decomposition.

Some typical process analyses are:

- Resource utilization;
- Distribution analysis;
- Cycle time analysis;
- Cost analysis;
- Software application usage;
- Global/Local process variations.

At this stage of the BPM life cycle it is necessary to observe the processes exactly the way they are happening in the company at the time, only then can you get a “picture” that will help modeling and the evaluation of the organization’s processes. It is with this analysis of the present
moment that you can understand what could be improved, targeting the following phases of the BPM lifecycle (Morais et al., 2014).

Process Redesign

Is the act of transforming an organization’s vision, goals, and available resources into a discernible, measurable means of achieving the organization’s vision. It focuses on defining what the organization will do to achieve its financial and other goals and is the time to make decisions about everything that was detected in the previous phases.

Now that there is an awareness of bottlenecks, failures, delays and other shortcomings from the reporting process, with the greatest detail as possible, it is now time to align with the strategic goals of the company and design a new process. For this, it cannot fail to have simulations based on the studied scenarios and include the necessary improvements (van der Aalst, 2013).

The steps of this stage are as follows:

- Analyze gaps and make comparisons;
- Design the process and analyze IT use;
- Model the new process;
- Get new process procedures accepted;
- Deployment Plan Creation.

Process Implementation

Implementation is a phase of the BPM life cycle that can be performed in two ways. Through a systemic implementation, that is with the aid of specific software and technologies, or non-systemic implementation, without these types of BPM tools.

Regardless of which is used, the goal is the same, to enable and put into action process implementation as defined and documented in the form of a workflow previously defined (van der Aalst, 2013).

Process Monitoring and Controlling

Every company has strategic goals and it is at this stage of the BPM life cycle that it can find out if the processes are aligned with these objectives or not, by monitoring appropriate indicators to assess the results obtained.

The most commonly used performance indicators usually involve four dimensions: the length of process time, monetary cost spent on the process, capacity, as in how much can the process actually produce, and quality, which examines whether there are many errors and variations that affect a satisfactory delivery to customers in the process (Morais et al., 2014).
2.3 Business Process Management Systems

For a successfully implementation of BPM in an organization, it’s important to know that on his pillar there will be technology tools. There is already a set of tools designed for that purpose, they are called Business Process Management Systems (BPMS). Its objective is to allow a more efficiently interaction between the organizational and technologic worlds. These tools make possible to execute any necessary operations about business process and monitor a BPM project, form the beginning until the end, trough modelling, implementation, development, execution and process optimization.

With the organization’s complexity increasing, business process has been getting more complicated. This fact made more important the utilization of tools that allow they’re management. These tools were manly based on information technology. It’s also important for these technologies to be able to cover all the BPM lifecycle.

These systems are a set of techniques that seek constant system management optimization and be complementary to the traditional informatic structures in the pursuit of promoting client satisfaction. They promote the constant interaction between people and process, define the information access, support process flow and manage exceptions.

BPMS benefits organizational management, promoting communication and people integration, supporting and simplifying planning, structuring and activities controlling. Also giving better agility and flexibility in functional business changes.

BPMS can also help organizations reduce process response time, reducing errors due to the countless information transitions, reduce the costs and function optimization (Karagiannis, 1995).

These technological tools can be seen as software tolls, because they are able to support activities like modulation, analyses and optimization of business process.

The implementation of these tools needs a responsible methodology that incorporates several methods and techniques suited for the support of the various activities that constitute a Business Process Management.

BPMS tools should be able to serve some scenarios:

- Business management critical identification and modulation processes;
- Scheme identification understanding, acceptance and execution, and process interaction and sequencing;
- The creation of pillars for the process management system integration with the information technology environment;
- The acceptance of the criteria and methods proposed by the organization, to ensure the organizational processes effective execution and monitoring;
- Availability of organizational processes information in adequate time;
- Possibility of activities monitoring, by controlling the organizational processes performance and functioning;
- Functionalities for the current structure, simulation and optimization analysis of the organizational processes;
Resources that gives the possibilities for actions that focus on obtaining planned results and continuous improvement of business processes.

There is also a set of four essential functionalities that BPMS tools must provide to cover the BPM lifecycle of any project.

Process definition by giving supports to the design of the process model, presenting all the information necessary for the system to execute the process, like the rules of the processes, the users covered and the documents that involve each activity (Puntar, Iendrike, & Santoro, 2009).

Control of process execution by letting BPMS control and dictate how the sequence of executions should occur, and consequently their instances activation. The instances can vary in number and be associated to one or several processes and be simultaneously running in a BPMS, being it responsible for how and when the activities execute.

Interaction control by adding elements to the worklist of the workers when there’s an activity forwarded to them. The lists contain several instances of the running processes. The workers responsible have access to their work lists and then can select the tasks they want to perform. Executions of these tasks involve document manipulation, decision making, and data completion. The completion of the task by the responsible worker replaces the process flow and activates new activities according to the expected results.

Management and controlling of the execution processes, by presenting the its own process model, several information about the preformed activity state, either in execution or to be performed and by having resources that allow to make performance measures and produce statistics for projections of the process optimization.

The primary objective of business process modeling tools is to analyze how things are right now and simulate how should they be carried out to achieve better results (Oliveira, 2008; Reijers, 2006).

2.4 Business Process

A business process is a set of related and structured activities that produce a type of service or product for a certain customer. It’s often seen as flowchart of a sequence of activities with interleaving decision points, and in other cases a process matrix of a sequence of activities with rules based on data in the process.

When a business process is too complex it may be decomposed into some sub-processes. These sub-processes have their own attributes, but also aid the super-processes in achieving their goal. The business process analysis usually includes the mapping of processes down to activity or task level.

Business processes are made to add value to the customer and unnecessary activities should be excluded, because the outcome of a well-designed business process it’s value to the customer, or effectiveness, and less use of resources, or efficiency.
Business processes can be modeled by various methods and techniques, just like BPMN, CMMN and DMN (these will be presented further on), that can be used to draw business process in a workflow (Verner, 2004).

A business process is a set of structured and measurable activities that get a certain input and then develop an output with value for the client. These activities define “How”, “Who”, “When”, and “Where” the process is executed, building a flow of information according to the functioning areas of the organization.

Business process has the objective of establishing how the work should be performed by the participant people, machines and applications to give response to the different phases that constitute the production or realization of a determinate service or product, assuring the best possible performance of the organization. In other cases, a set of miss-structured or wrongly executed business processes may compromise the survival of the organization.

Business process can be arranged in three types:

- **Operational processes**: processes to constitute the core of the entire business and to create the primary value stream. They are responsible for directly guaranteeing value for the costumer and involve all the nuclear activities for the survival of the organization. They are present throughout all the procedure and showing a complete vision of all the production or service steps;

- **Supporting processes**: supports the core processes, like accounting, recruitment or technical support. As the name suggests, are made to give support to all other processes in the organization. Its main function is to help other processes raise their capacity in the realization and execution of the objectives. These should also cover all the organization;

- **Management processes**: these are the processes that manage the system’s operation. Usually it includes corporate governance and strategic management. They have the objective of controlling and managing the activities and the hole business. Even though they don’t add direct value to the costumer, they are essential for the maintenance of the high level of quality of the organization in the way it accomplishes the work according with the established rules to match its goals and objectives.

In conclusion a business process coordinates the behavior of people, systems, information and things to produce business outcomes in support of a business strategy (Fiol, 2014).
3. Process Modeling

Process modeling is mainly used to map a workflow, so we can understand, analyze and make positive changes to that workflow or process and finding ways to improve them. The usage of diagram helps to visualize this process and make better decisions. Business process modeling can also help you group similar processes together and anticipate how they should operate.

There are many benefits to business process modeling:

- Gives everyone a clear understanding of how the process works;
- Provides consistency and controls the process;
- Identifies and eliminates redundancies and inefficiencies;
- Sets a clear starting and ending to the process.

There are a lot of different techniques to model processes, like UML Diagrams, Flowchart Technique, Data flow diagrams (DFD), Role Activity Diagrams (RAD), Role Interaction Diagrams (RID), Gantt Charts, Integrated Definition for Function Modeling (IDEF), Colored Petri Nets (CPN) or Workflow Technique, but in this project, we will focus on three OMG business modeling notations that are Business Process Management and Notation (BPMN), Case Management Model and Notation(CMMN), and the Decision Model and Notation (DMN).

3.1 Business Process Management and Notation

A Business Process Model is a network of graphical objects, where there are activities and flow controls that define how they operate and the order of performance.

BPMN’s development is an important for reducing the fragmentation that occurs with the countless of process modeling tools and notations. This fragmentation has stopped the adoption of inter-operable business process management systems. So, a well-supported standard modeling notation will make it less confusing among business and IT users.

Another factor brought the development of BPMN is that business process models developed by business people have been different from the process representations that designed systems require to implement and execute those processes. Also, there was the need to translate the original business process models for the execution models and such translations can have errors that make it hard to understand the evolution and the performance of the processes to the process owners (Bossuyt, 2017).

BPMN as its primary goal set to offer a notation easily understandable by business users. There for it will make it simpler for business analysts, who create the initial draft of the processes, to the technical developers, who implement the technology that will perform those processes, and to the business people that will administrate, manage and monitor those process, to cooperate and work more efficiently. So, BPMN builds a standardized bridge between the business process design and the process implementation.

To make an easy development of simple diagrams that will be simple to understand by most of business analysts, there were made up a set of graphical elements. The chosen elements were
selected to give the user a distinguishable feel from each other and to use shapes more familiar to the greatest number of modelers (Fiol, 2014; White, 2004).

One of the main reasons for the development of BPMN was to create an easy mechanism for the creation of business process models and at the same time the ability of being able to handle the complexity of business process. The best solution fund to handle these conflicting requirements was to organize graphical aspects of the notation into specific categories, so that the reader can easily recognize the basic types of elements and get a better understand of the diagram. The four basic categories of elements are:

- Flow Objects;
- Connecting Objects;
- Swimlanes;
- Artifacts;

3.1.1 Categories of Elements

Flow Objects

The Flow Objects are a set of only three core elements, so that modelers don’t have to learn and memorize many different shapes. The three Flow Objects are:

- Event: Is represented by a circle and is something that “happens” during the course of a business process. These Events affect the flow of the process and usually have a cause or a trigger and an impact or result. Events are circles with open centers to allow internal markers to differentiate different triggers or results. There are three types of Events, based on when they affect the flow: Start, Intermediate, and End (respectively in the order of the image) (Figure 2).

![Figure 2 – Events](image2)

- Activity: Is represented by a rounded-corner rectangle and is a generic term for work that company performs. An Activity can be atomic or non-atomic. The activities have two types that can be Tasks or Sub-Process. The Sub-Process is distinguished by a small plus sign in the bottom center of the shape (Figure 3).

![Figure 3 - Activity](image3)
• Gateway: Is represented by the shape of the diamond and is used to control the divergence and convergence of Sequence Flow and will determine traditional decisions, as well as the forking, merging, and joining of paths. The type of behavior control will be indicated by Internal Markers (Figure 4).

![Gateway](image)

Figure 4 - Gateway

Connecting Objects

The Flow Objects are connected in a diagram to create the basic skeletal structure of a business process. There are three Connecting Objects that provide this function. These connectors are:

• Sequence Flow: Represented by a solid line with a solid arrowhead and is used to show the sequence that activities will be performed in a Process (Figure 5).

![Sequence Flow](image)

Figure 5 - Sequence Flow

• Message Flow: Represented by a dashed line with an open arrowhead and is used to show the flow of messages between two separate Process Participants, like business entities or business roles, that send and receive them (Figure 6).

![Message Flow](image)

Figure 6 - Message Flow

• Association: Represented by a dotted line with a line arrowhead and is used to associate data, text, and other Artifacts with flow objects. Associations are used to show the inputs and outputs of activities (Figure 7).

![Association](image)

Figure 7 - Association
SwimLanes

Many process modeling methodologies utilize the concept of swimlanes as a mechanism to organize activities into separate visual categories in order to illustrate different functional capabilities or responsibilities. BPMN have swimlanes with two main constructs that are:

- **Pool**: Represents a Participant in a Process. It is also acts as a graphical container for partitioning a set of activities from other Pools. They are used when the diagram involves two separate business entities or participants and are physically separated in the diagram. The activities within separate Pools are considered self-contained Processes, so for that reason the Sequence Flow may not cross the boundary of a Pool. Message Flow is defined as being the mechanism to show the communication between two participants (Figure 8).

![Figure 8 – Pool](image)

- **Lane**: Is a sub-partition within a Pool and with the extend of the entire length of the Pool, vertically or horizontally. Lanes are used to organize and categorize activities. Lanes are often used to separate the activities associated with a specific company function or role. Sequence Flow may cross the boundaries of Lanes within a Pool, but Message Flow may not be used between Flow Objects in Lanes of the same Pool (Figure 9).

![Figure 9 - Lane](image)

Artifacts

BPMN was designed to allow modelers and modeling tools some flexibility in extending the basic notation and in providing the ability to add context appropriate to a specific modeling situation. Any number of Artifacts can be added to a diagram, as appropriate for the context of the business process. The current version of the BPMN specification only defines three types of Artifacts, which are:
• Data Objects: Is a mechanism to show how data is required or produced by activities. They are connected to activities through Associations (Figure 10).

Figure 10 - Data Objects

• Group: Represented by a rounded corner rectangle drawn with a dashed line. The grouping can be used for documentation or analysis purposes but does not affect the Sequence Flow (Figure 11).

Figure 11 – Group

• Annotations: Is a mechanism for a modeler to provide additional text information for the reader of a BPMN Diagram (Figure 12).

Figure 12 - Annotations

3.1.2 Example of BPMN

Figure 13 - BPMN example
In this example we can see a process that was is goal as sending a job offer letter to a successful job applicant (Figure 13). The context is that recruiting an employee requires a long-elapsed time to complete and involves a certain number of people. Unless very few people apply for jobs, the recruitment will have to handle many cases at the same time. This process requires someone to assign tasks to the people who do different types of work, such as interviewing or preparing a contract.

The present action is a recruitment process that consists of a series of decisions, to reject the candidate or continue. This simplified process has these decision points after evaluating the applicant’s CV and a single interview.

If the hiring manager rejects the applicant at any stage, it sends a standard rejection email.

There are also a series of roles that must be present for the process to function properly. They are the hiring manager, that is the person who takes responsibility for assessing a candidate and whether to reject the candidate or proceed and the recruiter, that is a human resources assistant who coordinates the recruitment process.

### 3.2 Case Management Model and Notation

The Case Management Model and Notation was created by the Object Management Group and has published in 2014. It is a notation that came to complement the Business Process Model and Notation.

The Case Management Model and Notation is a type of business process technology that doesn’t use control flow to describe the process. The case file or case folder is the main concept that has all the data and information about the process. Case management has the function of providing the workers with discretion and control on how a case evolves, there for, case management isn’t about the process, but about the workers.

As mostly appends in regular workflows or process systems, the designer encodes the business goal to be accomplished in the model, so this means that the system is responsible for the that goal and it uses the workers to achieve it. But in case management systems it’s the other way around, the workers are responsible for the business goal and they use the system as a tool to accomplish that goal. This is the reason that case management relies more on the judgment of workers than ins control flow (Marin, 2016).

CMMN is declarative by nature, thus one should not read any meaning into the relative positioning of shapes and describes what is allowed and disallowed in the process as opposite of BPMN, that is imperative, as in, it describes “how” to do the process (OMG, 2014).

The case is the main concept in CMMN, and it is like a process. A case has a case file that is described by a case plan. The categories of elements are:

- Case Plan Models;
- Case File Items;
- Stages;
- Entry and Exit criteria;
- Plan Fragments;
• Tasks;
• Milestones;
• Event Listeners;
• Links;
• Connector Usage;
• Planning Table;
• Decorators;
• Artifacts.

3.2.1 Categories of Elements

Case Plan Models

The complete behavior model of a Case is captured in a case Plan Model. Its represented by using a “Folder” shape (Figure 14).

The various elements of a case Plan Model are represented within the boundary of the case Plan Model shape.

![Figure 14 - Case plan](image)

Case File Items

A Case File Item is depicted by a “Document” shape that consists of a rectangle with a broken upper right corner (Figure 15). Case file items are used to represent all kinds of data, including a data value in a database, a row in a database, a document, a spreadsheet, a picture, a video, a voice recording, etc. In addition to basic data, case file items can also represent containers, including, a directory, a folder, a set, a stack, a list, etc.

![Figure 15 - Case file item](image)
Stages

A Stage is depicted by a rectangle shape with angled corners and a marker in the form of a “+” sign in a small box at its bottom center. When the Stage is expanded it is shown with the marker in the form of a “-” sign in the same small box (Figure 16).

A Stage may be discretionary, that has the shape of a rectangle with short dashed lines and angled corners and a marker in the form of a “+” sign in a small box at its bottom center, while a discretionary expanded Stage has a “-” sign in a small box at its bottom center.

When a Stage is expanded, elements that are contained in it become visible.

![Figure 16 - Stage](image)

Entry and Exit Criterion

Plan Items may have associated Sentries. When a Sentry is used as an entry criterion it is depicted by an allow “Diamond” shape (Figure 17). Describes the condition that must be satisfied for the stage, task, or milestone to be available for execution.

![Figure 17 - Entry criterion](image)

When a Sentry is used as an exit criterion it is depicted by a solid “Diamond” shape (Figure 18). Is similar to an entry criterion, but it is used to stop working on the stage, task, or case plan when it is satisfied.

![Figure 18 - Exit criterion](image)

Plan Fragments

A Plan Fragment is depicted by a rectangle shape with dashed lines and softly rounded corners and a marker in the form of a “+” sign in small box at its bottom center. When the it is expanded it is depicted by a “-” sign in a small box at its bottom center (Figure 19).
Tasks

A Task is depicted by a rectangle shape with rounded corners (Figure 20). A task represents the execution of actual work. There are four types of tasks, namely non-blocking human task, blocking human task, case task, and process task.

A Task may be discretionary, that is represented by a rectangle shape with dashed lines and rounded corners.

A Task may be associated with one or more entry or exit criteria Sentries.

Human Task

A Human Task has two possible depictions. If the Human Task is non-blocking, it is represented by a rectangle with rounded corners and a “Hand” symbol in the upper left corner (Figure 21). Non-blocking human tasks are handed out to a case worker and as soon as it is claimed by a case worker, it will be considered complete.

If the Human Task is blocking, it is represented by a rectangle with rounded corners and a “User” symbol in the upper left corner (Figure 22). Blocking human tasks are executed by a case worker and they must be explicitly completed by the worker.
A Human Task may also be discretionary and by then represented by a rectangle shape with dashed lines and rounded corners with the appropriate marker depending if it is blocking or not.

Case Task

A Case Task is represented by rectangle shape with rounded corners with a “Folder” symbol in the upper left corner (Figure 23).

A Case Task may also be discretionary and is represented by dashed lines.

Process Task

A Process Task is depicted by a rectangle shape with rounded corners with a “Chevron” symbol in the upper left corner (Figure 24).

A Process Task may also be discretionary and is represented by dashed lines.

Decision Task

A Decision Task is depicted by a rectangle shape with rounded corners with a Decision Table symbol in the upper left corner (Figure 25).
A Decision Task may also be discretionary and is represented by dashed lines.

Milestones

A Milestone is portrayed by a rectangle shape with half-rounded ends and may have zero or more entry criteria (Figure 26). Represent accomplishments during the execution of the case instance.

Event Listeners

An Event Listener is represented by a double line circle shape with an open center so that markers can be placed within it to indicate its variations (Figure 27). Events listeners are similar to events in other workflow or BPM notations.

A Timer Event Listener is represented by double line circle shape with a “Clock” marker in the center (Figure 28). As the name suggest it regulated by the time.

A User Event Listener is represented by double line circle shape with a “User” symbol marker in the center (Figure 29). In this case is regulated by the user.
Links

Certain dependencies between elements that are shown inside expanded Stages or Plan Fragments are connected by using links. These connector’s shape object is a dash-dot-dot line that must not have arrowheads (Figure 30).

---

The other type of dependency that is visualized is the dependency between a Human Task and Discretionary Items in its Planning Table. When the Human Task is shown with its Planning Table expanded, these dependencies are depicted with a discretionary association that is a dashed line and it must not have arrowheads (Figure 31).

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Connector Usage

The following picture illustrates a situation where task can only be activated if both previous tasks are complete, in other words a “and” situation (Figure 32).

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In this picture is illustrated a situation where a task can be activated if either previous task is completed, in other words a “or” situation (Figure 33).
Planning Table

A Planning Table may exist in a Stage or a Human Task. It is represented by a “Table” shape composed of six cells with the center bottom cell containing a marker indicating if the Discretionary Items are visualized or not. When there are not visualized a marker in the form of a “+” sign is present in the bottom center cell (Figure 34), otherwise the marker in the form of a “-” sign (Figure 35).

The Planning Table shape can only be placed as a decorator on the boundary of a Stage or a Human Task object.

When a user expands a Planning Table, its contained Discretionary Items become visible within the Stage (Figure 36).
Decorators

For the CMMN notation to be as expressive as possible, different shape decorators are introduced. These decorators are useful to visually indicate some behavior patterns of Plan Items and Discretionary Items.

AutoComplete Decorator

When a Stage Auto Complete attribute is set to “True”, then an AutoComplete decorator is added to the bottom center of the Stage shape. The AutoComplete Decorator is a small black square (Figure 37). It indicates that the stage or case (case plan) will complete when all the required case plan items are completed.

\[\text{Figure 37 - AutoComplete decorator}\]

Manual Activation Decorator

The Manual Activation Decorator, representing a Manual Activation Rule, is a small white-filled triangle pointing to the right, and is visible when a Manual Activation Rule is defined for the Plan Item or Discretionary Item (Figure 38). A task with a manual activation decorator means that a case worker must decide if the task should be executed or not.

\[\text{Figure 38 - Manual activation decorator}\]

Required Decorator

The Required Decorator is a bold black “Exclamation” symbol and is visible when a Required Rule is defined for Plan Item or Discretionary Item (Figure 39). It indicates that a stage, task, or milestone must be executed for the stage or case to complete.
Repetition Decorator

The Repetition Decorator, portraying a Repetition Rule, consists of two bold vertical bars crossed by two bold horizontal bars (identical to ASCII # symbol), and is visible when a Repetition Rule is defined for a Plan Item or Discretionary Item (Figure 40). It indicates the stage, task, or milestone can be repeated multiple times.

Artifacts

Case Models may also contain any number of artifacts representing annotations of the diagram. There are two types of artifacts:

• An Association: is a dotted connector used to link a Text Annotation to a CMMN Element;
• A Text Annotation: is entered text used for comment or to give an explanation.

Association

An Association is line that must be drawn with a dotted single line (Figure 41).

If there is a reason to put directionality on the Association, then an arrowhead may be added to the Association line (Figure 42). The directionality of the Association can be in one direction or in both directions.
Text Annotation

Text Annotation objects can be used by the modeler to display additional information about a Case of attributes of the objects within a CMMN Diagram. A Text Annotation is an open rectangle that MUST be drawn with a solid single line (Figure 43).

The Text Annotation object can be connected to a specific object on the Diagram with an Association but does not affect the execution of the model. Text associated with the Annotation can be placed within the bounds of the open rectangle.

3.2.2 Example of CMMN

This example demonstrates a CMMN diagram containing a case plan model, that is the essential part of any CMMN case definition (Figure 44).
In the first part of the case, the loan application should be reviewed for any formal errors, so it’s used a human task. Additionally, the customer’s creditworthiness must also be assessed. In this case is defined that the human tasks don’t need manual activation.

Next its added a milestone. The condition(s) defining when the milestone is reached are modeled using Sentries. Sentries are used to capture conditions within a case and can trigger other events to occur. In this case the Approved milestone is reached when both tasks have successfully completed, if the application was sufficient and if the customer received a good rating for creditworthiness. But when a loan application is not sufficient, there is no need to provide a customer rating any longer and this is express by adding a sentry which acts as exit criterion.

3.3 Decision Model and Notation

Decision Model and Notation was published by the Object Management Group in 2015 and its main purpose is to become a common notation, just like BPMN. Trying to make so that it is understandable by all business users, to will ensure interchangeability of decision and process models across organizations.

The primary goal of Decision Model and Notation is to provide a common notation for decision logic that is understandable for business users, business analysts and technical developers.

It allows designers to model decision logic independently, or in combination with the already established standard BPMN.

In most process models with a lot of detailed decision logic, the result ends up in a complex and confusing spaghetti-like models. So, the primary objective is to separate decision logic from the process model to improve simplicity, precision, readability and maintainability of both models. A simplified business process model is easier to read and maintain and any change is necessary to make it doesn’t impact the whole process model (Bossuyt, 2017).

Another benefit DMN is that a detailed decision logic leads to opportunities regarding automated decision-making, and there for automated processing, that would lead to the least necessity for human intervention during the process, freeing up expensive resources to other activities with more value. Because DMN allows for explicit decision modelling, it becomes clear to where exactly the decision could be improved.

A company is only as agile as its business processes, there for a simplification will leads to a more agile business. The purpose of adding DMN to an already existing business process is to facilitate interchangeability and reusability of decision models and adding this to the fact that business process models are the most important part in designing information systems, development and maintenance costs have the chance to be reduced significantly (“DMN Tutorial,” n.d.).

The Decision Model Notation can be modelled using a combination of four elements and three requirements.

3.3.1 Categories of Elements
Elements

- **Decision:** A decision denotes the act of determining an output from a number of inputs, using decision logic which may reference one or more business knowledge models (Figure 45).

![Decision](image1)

*Figure 45 – Decision*

- **Business Knowledge Model:** A business knowledge model denotes a function encapsulating business knowledge (e.g., as business rules, a decision table, or an analytic model) (Figure 46).

![Business knowledge](image2)

*Figure 46 - Business knowledge*

- **Input Data:** An input data element denotes information used as an input from one or more decisions. When enclosed within a knowledge model, it denotes the parameters to the knowledge model (Figure 47).

![Input data](image3)

*Figure 47 - Input data*

- **Knowledge Source:** A knowledge source denotes an authority for a business knowledge model or decision (Figure 48).

![Knowledge source](image4)

*Figure 48 - Knowledge source*

Requirements
• Information Requirement: An information requirement denotes input data, or a decision output being used as one of the inputs of a decision (Figure 49).

Figure 49 - Information requirement

• Knowledge Requirement: A knowledge requirement denotes the invocation of a business knowledge model (Figure 50).

Figure 50 - Knowledge requirement:

• Authority Requirement: An authority requirement denotes the dependence of a DRD element on another DRD element that acts as a source of guidance or knowledge (Figure 51).

Figure 51 - Authority requirement

3.3.2 Example of DMN

This table contain the decision logic about the desired dish for a given season and guest count (Figure 52).
To begin the fields are filled in to set the conditions and the results of the decision, then the rules that specifies what desired dish for each season and the guest count are inputted. In this case the ruling process is that the season and the guest count are the conditions or input entries of the rule and the dish is the conclusion or output entry of the rule. There is also a Hit Policy (in this case is a “UNIQUE” type) that dictates that only one option can be the final result.

3.4 BPMN + CMMN + DMN

![BPMN + CMMN + DMN example](image)

This example demonstrates a car insurance application process (Figure 53). Its function is to allow to see the viability of the usage of the three OMG business modeling notations that are Business Process Management and Notation (BPMN), Case Management Model and Notation (CMMN), and the Decision Model and Notation (DMN) and how they can serve a much better understanding of a complex process.

In this case there is received a car insurance application and a process to determine if its passive of being accepted or not. It starts by determining the risks, so DMN is used to prevent a large cascade like set of gateways and for that is inputted a set of conditions to get an output of results, that can be decisive or inconclusive. When the process results are conclusive BPMN sends the results of the application and ends the process, but when the process is inconclusive there is the need for the utilization of CMMN to manually check the application and then proceed by providing BPMN with the final decision, so it send the result and end the process.
4. Methodological Approach

To carry out this project, the methodological approach followed will be the Design Science Research (DSR), that according to Vaishnavi Kuechler which are cited by (Da Silva, J. V. V. M.; Da Costa, R. M.), is an analytical set of techniques and perspectives (complements the positivist and interpretative perspectives) to carry out studies in Information Systems. It involves the analysis of the use and performance of artifacts designed to understand, explain and improve the behavior of the aspects under study (Vaishnavi and Kuechler, 2006). Wang and Wang (2003) refers DSR to a set of specific guidelines and methods for the process of creating, constructing and validating an artifact in the context of IT innovation. These artifacts are usually designed to satisfy a need or to serve a purpose (Simon, 1996).

![Figure 54 - Design science research process model by Peffers et al. ([15], p. 54)](image)

This methodology (Figure 54) is summarized very quickly in 6 steps, the first being the "Identify Problem and Motivate", the second the "Define Objectives of a Solution", the third is the "Design and Development", the fourth is the "Demonstration", the fifth is the “Evaluation”, and final one is the "Communication".

During this project I will follow an exploratory approach, since in this area there is still little knowledge and information available. So, I will explore the various existing solutions and choose the best.
5. Work Plan

The objectives defined for the development of the dissertation was made as can be seen in the Figure 54.

In this plan two major phases. The Dissertation Project, where there are an initial four tasks, and the Dissertation that includes the following five phases after the dissertation project has been delivered.

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Start</th>
<th>Finish</th>
<th>Duration</th>
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<td>19/02/2018</td>
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<td>Proposal Analysis</td>
<td>20/10/2017</td>
<td>24/10/2017</td>
<td>3d</td>
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<tr>
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<td>Literature review</td>
<td>25/10/2017</td>
<td>22/12/2017</td>
<td>43d</td>
</tr>
<tr>
<td>4</td>
<td>Writing of the state of the art</td>
<td>18/12/2017</td>
<td>16/02/2018</td>
<td>45d</td>
</tr>
<tr>
<td>5</td>
<td>Elaboration and delivery of the dissertation project</td>
<td>10/01/2018</td>
<td>19/02/2018</td>
<td>39d</td>
</tr>
<tr>
<td>6</td>
<td>Dissertation</td>
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<td>19/10/2018</td>
<td>173d</td>
</tr>
<tr>
<td>7</td>
<td>Study of the three languages of process modeling</td>
<td>21/02/2018</td>
<td>12/04/2018</td>
<td>37d</td>
</tr>
<tr>
<td>8</td>
<td>Criteria and metrics identification for the conjugation of modeling languages</td>
<td>02/04/2018</td>
<td>30/04/2018</td>
<td>21d</td>
</tr>
<tr>
<td>9</td>
<td>Study of Business Process Management Systems capable of supporting all three languages</td>
<td>01/05/2018</td>
<td>03/06/2018</td>
<td>29d</td>
</tr>
<tr>
<td>10</td>
<td>Production of the conjugation artifact of the three modeling languages</td>
<td>11/06/2018</td>
<td>31/08/2018</td>
<td>60d</td>
</tr>
<tr>
<td>11</td>
<td>Writing and deliver of the dissertation</td>
<td>03/09/2018</td>
<td>19/10/2018</td>
<td>35d</td>
</tr>
</tbody>
</table>

Dissertation Project

Task 1 – Proposal Analysis: In this phase it is expected a detailed study of the proposal to identify the objectives and basic concepts of research for the development of the dissertation.

Result: Key words and research concepts.

Task 2 – Literature review: Phase of investigation and search of bibliographical sources using the keywords identified in the previous phase. The searches were carried out in several places, like google scholar, manuals, school platform, etc.

Result: Acquisition of relevant articles and bibliographic sources.
Task 3 – Writing of the state of art: Reading, reviewing and organizing all the relevant information of the investigation. Also, the writing of a document that includes all the previous work and addresses all the identified topics.

Result: Document with the state of the art.

Task 4 – Elaboration and delivery of the dissertation project: Production of a well-structured document built on the framework of the research, the methodological approach carried out in the dissertation and in the state of the art previously written, reviewed and finalized. After its completion, the delivery of the revised dissertation project document.

Result: Finalization and deliver of the Dissertation Project.

Dissertation

Task 5 – Study of the three languages of process modeling: Study of a more specific analysis of the three process model notations. Then it should be identified its components, main characteristics, their histories and their strengths and weaknesses, etc.

Expected Result: Detailed analysis of modeling notations.

Task 6 – Criteria and metrics identification for the conjugation of the modeling languages: It consists on a study for the identify of how the three languages can be conjugated in a more solid way. There is a search for a certain criterion that allows it to do it in the most proper way and arrive at conclusive results.

Expected Result: Criteria for the conjugation of the notation languages.

Task 7 – Study of BPMS capable of supporting all three languages: Consist on the search and study of a business process modeling system that can integrate all three languages in the same business process model.

Expected Result: BPMS capable of supporting all three languages in the same business process.

Task 8 – Production of the conjugation business process using the three modeling languages: Construction of a business process that serves to conjugate the three modeling languages, based on previously defined criteria.

Expected Result: Business process of the conjugation of the notation languages.

Task 9 – Writing and deliver of the dissertation: Production of the final dissertation report, which encompasses all the research and work carried out in the previous phases. Finalization and delivery of the final dissertation document reviewed.

Expected Result: Completion and delivery of final Dissertation Document.
6. Conclusion

In this chapter a summarization of the efforts and work made towards each of the defined objectives is expressed. Also, there is a presentation of the main conclusions of the work accomplished so far.

The literature review made me expand the range of knowledge regarding the BPMN, CMMN and DMN languages, as in, all the languages were explored in its elements, methods and functionalities. This explorational phase was meant to find fundamental roles for these languages in improving the management of business processes, and consequently in increasing the efficiency of the organizations, so they can be able to keep up with the new requirements of its surroundings. It is also important to define new organizational processes that in the future can bring added value to the organization.

In process modeling the use of a specific notation is crucial. Some business process can get too extensive and long using the most common notation that is BPMN, but with the addiction of these other two languages, business process can become much more simple, comprehensive and easy to modify, making this hybrid use of the languages a great possibility of becoming the common modulation way. In another point of view if this phase of any BPM approach is not well structured, reflected, defined and modeled, or in other words, correctly carried out by the project team or the organizations, there is a big chance that this type of projects will be condemned to failure.

There is also the need of a BPMS capable of supporting all the three languages, that allows to model them together in the same process. There are not many tools capable of this feature in this moment but is believable than as soon as this hybrid modulation becomes more common there will be an increase of offering for this purpose.

Once these requirements are meet, the business process modeling will be reinvented, and all the processes will become more efficient and simpler. This will bring great success to the organizations, by saving them time and process complexity, there for help them grow and achieve success.
References


Fiol, M. B. (2014). Identificação de problemas em processos de negócio usando a modelagem de processos em BPMN e a árvore de realidade atual da TOC.


