Course Direction Support Information System

João Vitor Foralosso Gris

Project presented to the School of Technology and Management in the scope of the Master in Information Systems.

Supervisors:

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Dedication

This work is the result of the effort made for a long time, since joining the university in 2014 until now. I would like to dedicate this work primarily to my family, especially my parents (Lady and Sirlene) and brothers (José, Maria and Gabriel), who have always supported and loved me.

Another special thanks is to my girlfriend (Flávia), who supported and made me happy too many times to count, if it wasn't for you, it would be like i was alone.

My next dedication is to all the professors who supported, guided and encouraged me at some point during this walk, especially to my supervisors Prof. José Eduardo Fernandes, Prof. André Schwerz (UTFPR) and Prof. Maria João, who always advised me very well. Another thanks is to Professor Marcos Silvano (UTFPR), because without him, I would not have participated in the Double Degree project. The last thanks to professors is to my godmother, Fabiana Bortolini, who did not teach me but was always an inspiration to me.

Also, many friends of mine had a great positive influence at this stage, so I would like to leave a small thanks to the friends I made here in Bragança (Edmar, Diego, Bruno, Vinícius, Gabriela M., Milena, Felipe, Gabriela P., Mario, Kazim, Renato, John, Joao), to the friends who supported me during the university in Brazil (Henrique, Giovani, Everton, Lucas, Virgílio, Gilherme, Bruno, Marco, Gabriel, Davyllen, Yang, Emanuel, José Matheus, Victor, Gaia) and the friends from my city (Luiz S., Luiz T., Cauê).

Thank you so much, all of you brought me more joy and made this path much easier to follow.

Abstract

Many organizations today are investing their time and resources in ways to improve process execution and also to make the best use of their resources. In the ambit of the course directors, many processes are carried out, many referring to various areas of expertise and knowledge, ranging from scientific committee organization to dissemination of course proposals and projects.

Aiming to help improve the work of the directors a system that gathered some basic functionalities, such as attendance tests and time attendance, along with the process mapping was developed. Some of these processes were mapped from the general regulation of the IPB Master in Information Systems.

This system was built by joining a BPM engine, selected by a survey made with some BPM tools, and a conventional WEB application (DB and Website), where the website communicates with the engine through a REST API.

The result was a portal where professors can interact and perform some functions related to dissertation proposals and projects, can perform some activities related to the function of scientific committee like approve or not some proposals or projects, and, if is the director, can perform some searches and use verification functions exclusive to the director.

Keywords: IT, BPMN, BPMS, REST API, Processes, Information Systems

Resumo

Atualmente, muitas organizações estão investindo seu tempo e recursos para melhorar a execução do processo e também fazer o melhor uso de seus recursos. Dentro dos diretores do curso, muitos processos são realizados, muitos referentes a várias áreas de especialização e conhecimento, desde a organização do comitê científico até a divulgação de propostas e projetos de cursos.

Para ajudar a melhorar o trabalho dos diretores, foi desenvolvido um sistema que reunia algumas funcionalidades básicas, como testes de presença e presença de tempo, juntamente com o mapeamento de processos. Alguns desses processos foram mapeados a partir dos regulamentos gerais do Mestrado em Sistemas de Informação do IPB.

Esse sistema foi construído ao integrar um mecanismo BPM em um aplicativo WEB convencional (banco de dados e site), onde o site se comunica com o mecanismo por meio de uma API REST.

O resultado foi um portal no qual os Professores podem interagir e desempenhar algumas funções relacionadas a propostas e projetos de dissertação, realizar algumas atividades relacionadas ao papel do comitê científico como escolher juris ou avaliar propostas e, se for o diretor, executar funções de pesquisa e verificação exclusivas de diretor de curso.
Palavras-chave: BPM, BPMN, Processos, Sistemas de Informação, BPMS, Tecnologia da Informação, API REST.

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Chapter 1

Introduction

Nowadays, the course director is a very important function that has to be performed well so that the whole course can benefit and improve. The tasks performed by the director are linked to various areas, be they knowledge, management, communication or business. In addition this role is still a professor, and also has his duties and tasks as such. The principal should also be concerned about the quality of teaching and the regularity of class attendance, so it is always good that he can analyze data on this topic.

In addition to these daily tasks, some other processes occur and are also very important for course maintenance, these processes are linked to the final projects and can be tracked from proposal creation to public project discussion, and these processes not only concern to the principal as it relates to professors for some other functions they may perform within the academic context (member of a scientific commission or member of a judging board).

All these tasks are not so easy to accomplish, and the organization of an entire course is not easy either, so the idea arises of a tool that is able to simplify and merge some tasks in one place, organizing some of the functions that are performed.

1.1 Goals

This work had as main objective the creation of a software solution that could contain several functions that could make some parts of the course director's work simplified.

Another objective of this work was to analyze the course regulations and obtain some processes that happen and understand and map them to a model where their execution could be done through an information system.

Another objective, which was born out of curiosity about business process management, and which was pertinent to research due to the connection with the project, was to study Business Process Management tools, with the intention of finding any that could support the processes mentioned.

In the end the objective of the work was to join all tasks and processes in a system that could support the execution of the processes and also the functionality itself.

1.2 Development Method

This work was developed in different stages so that it could meet the requirements well and achieve the specified objectives.

The first part of the project was the analysis of course and management tasks and processes, coupled with a study in business process management. At these points, the necessary information was obtained to begin the planning and development of the software solution.

After these studies, a survey of requirements and processes was done to support the software project and also to verify the needs of the project.

After the requirements analysis, a literature-based analysis with some free business process management tools was conducted to find a process execution tool that could be integrated with an external project.

Finally, after the entire research process, the processes were modeled and the system implemented.

The breakdown of these steps is described in the next topic.

1.3 Document Structure

This document is divided into 6 chapters and one more section containing the attachments, which will be described next in a concise and succinct way. In the current chapter, number 1, there is a brief contextualization of all the subjects dealt in the document, objectives and the methodology used in the realization of the project. In the Chapter 2 the theoretical background to this project is given.

In the Chapter 3 tools studied are shown, explaining why they are chosen or not for use in the development of the project.

In chapter 4, it is presented how the project was developed in all its stages, from the conception and modeling of the processes, through the modeling of the software to the development of the solution.

In chapter 5, the results obtained are discussed, making an analysis of them, in this chapter, a conclusion is made and future work to be developed is also related.

Chapter 2

Theoretical Background

Nowadays in the market, many applications and techniques provide a range of features and standards to guide the development and modeling thereby facilitating to map processes more loyal to what happens in the real world business processes. The Business Process Management (BPM) can provide deeper view of how processes work, providing a way to create a model that covers the actual process completely. But, to create a good BPM System or integrate your application with one of them, modeling is not the only important thing to care about, there are several things to consider and many different platforms to be chosen to do this, some better than others depending on the context that they are applied. In this chapter some of the terms and concepts are presented along with their characteristics, since the basics, explaining what is a process, until the complex subjects like Business Process Management Systems (BPMS), making an introduction about the Business Processes World.

Before specifying a Business Process (BP), we must know what is a process, and, according to [1] a process can be defined as a sequence of operations made by a team, composed by people or systems, to get a result or a product, i.e., a sequential set of activities that lead to a determined purpose.

The key aspect of a BP is repeatability, which means a process is not a one-time thing.

Other definition is given by [2]:"Process is an aggregation of activities performed by humans or machines to achieve one or more results."

In this way, a BP is defined as a set of steps performed following a predetermined order to collectively achieve a goal, usually within an organizational structure [3].

The main benefit of business processes is that they streamline your business, this due to it can make the responsibilities clearer, so everyone knows what task they should work on, it will improve productivity, as tasks are communicated appropriately, each one can be more productive, since less time is spent on organizational issues, the time lost is less.

2.1 Business Process Management

The term BPM is a field of knowledge that is used to define, create models, perform execution, monitor, control and update business processes, whether computerized or not, to achieve results according to with the organization's objectives [2].

Either according [2] BPM represents a way of visualizing business operations and all the work performed to deliver the result of the process. It starts at a higher level (performs the work) and then subdivides into subprocesses that must be performed by one or more activities (workflows, can be broken down into tasks) within business functions (roles).

[2] gives a differentiation and makes an analogy between activities and processes: "While the activities represent the physical disposition of the work actually performed and the way to do it, the processes represent a logical composition of these activities. This physical and logical view on processes is analogous to the physical and logical view on data (as shown in Figure 2.1), where data is physically stored in tables and logical views on that data (views) can be constructed."

BPM aims to bring about a holistic perception of process-oriented strategic management, seeking to visualize all its elements and all areas involved in its realization. Where the goal is to find the efficiency and undeniable business, creating a map of continuous improvement and applying technology as a tool to provide speed and recognition.

BPM has an ongoing commitment from the organization to manage its processes, which includes a set of activities that are: diagramming, verification, design, performance

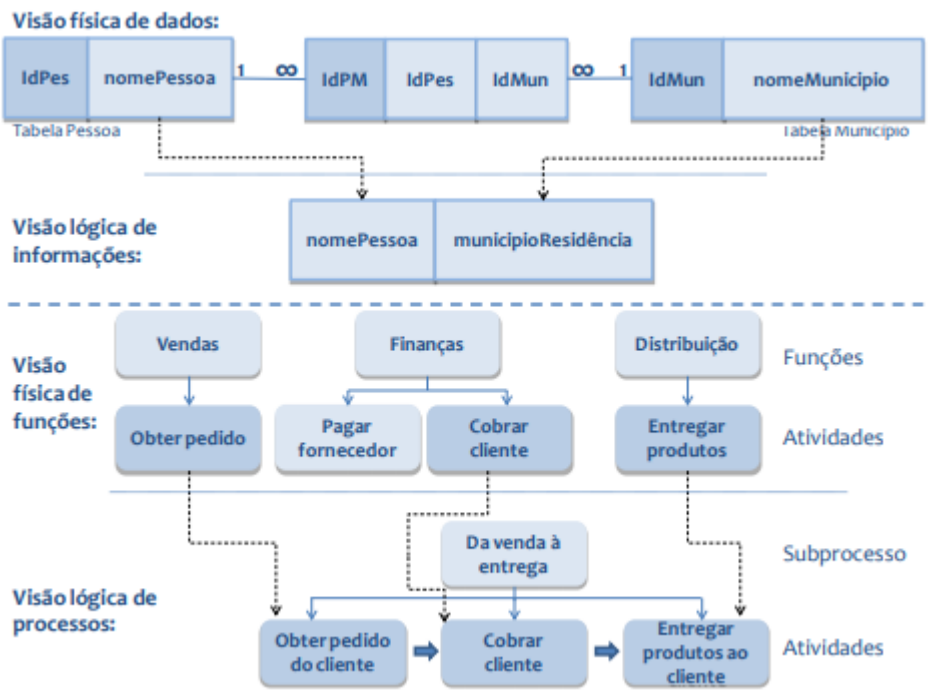

Figure 2.1: Analogy between physical and logical view of data and processes - Fonte: ABPMP BPM CBOK

monitoring and process transformation. It involves a continuous cycle (as shown in Figure 2.2) to ensure that business processes meet the company's organizational strategy, According to [2].

2.2 Business Process Modeling

Business Process Modeling is the way used to represent visually a BP in a diagram form, is defined as a set of activities involved in creating a representation of an existing or proposed business process to allow its analysis, design, and measurement [4].

According to [5], a business process model can describe the way how business works, how it accomplishes objectives, and describe how activities and tasks are performed.

Business process modeling is a means of representing business activities, information flow, and decision logic in business processes. What makes such a model so good to use is the power of visualization, which is used to communicate information about a process and

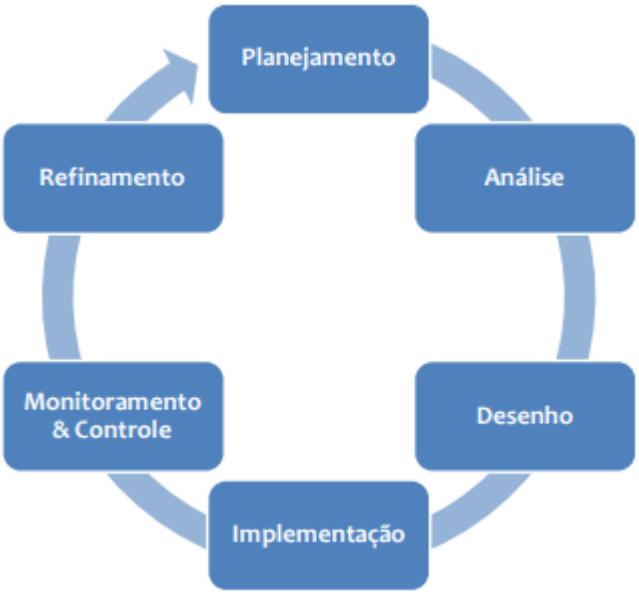

Figure 2.2: BPM life-cycle - Fonte: ABPMP BPM CBOK

the interaction it includes in organizations, . It cannot have many levels of granularity: from simple workflow representation to simulation and execution. One of the biggest gains is achieving a common understanding of business knowledge within or between an organization.

There are a lot of ways to do BP modeling and each one provide a different view of the same process if it used correctly, we can list some of them: Flow Chart Technique: Gantt Chart, Colored Petri-Nets (CPN), Object Oriented Methods (OO), Business Process Modeling and Notation (BPMN), Unified Modeling Language (UML), Activity Diagram, etc.

In this work we chose to use bpmn due to the fact that both student and advisors have a prior contact with BPMN and in order to try to exploit the advantages of BPMS, and to use an alternative way of modeling some business processes, in order to escape conventional UML models.

2.2.1 Business Process Modeling and Notation

The main objective of Business Process Modeling and Notation BPMN, is support Business Process Modeling by providing a standard notation that is comprehensible to business users yet represents complex process semantics for technical users, doing it by providing a graphical notation for specifying business processes in a Business Process Diagram [6].

BPMN is actually in version 2.0.2 (BPMN 2.0.2), which was released in 2014, and has been undergoing changes since its first release (2007), to better meet the needs and also provide a set of specifications that allows creating models that describes better to real world processes. It use a set of elements to represent processes, and the basic elements categories are: Flow Objects, Connecting Objects, Swimlanes and Artifacts.

For each category there are a set of elements that can be used in the diagramming, they are described below in the next subsections.

Flow Objects

Flow Objects are the main graphical elements for defining the behavior of a business process. BPMN describes a set of three flow objects: events, activities, and gateways.

Events

An event is something that happens during the execution of the process. These affects process execution and usually has a cause (trigger) and an impact (result). Events can be of three types, based on when they affect the process: Start, Intermediate, and End. Events may also occur during an activity. This is known as a Border event. For example, you might get a task with a deadline. The deadline would be shown as a time event in a human task activity. To indicate the "type" of event, an icon is added to the center of the circle. This provides further insight into what kind of event the circle represents.

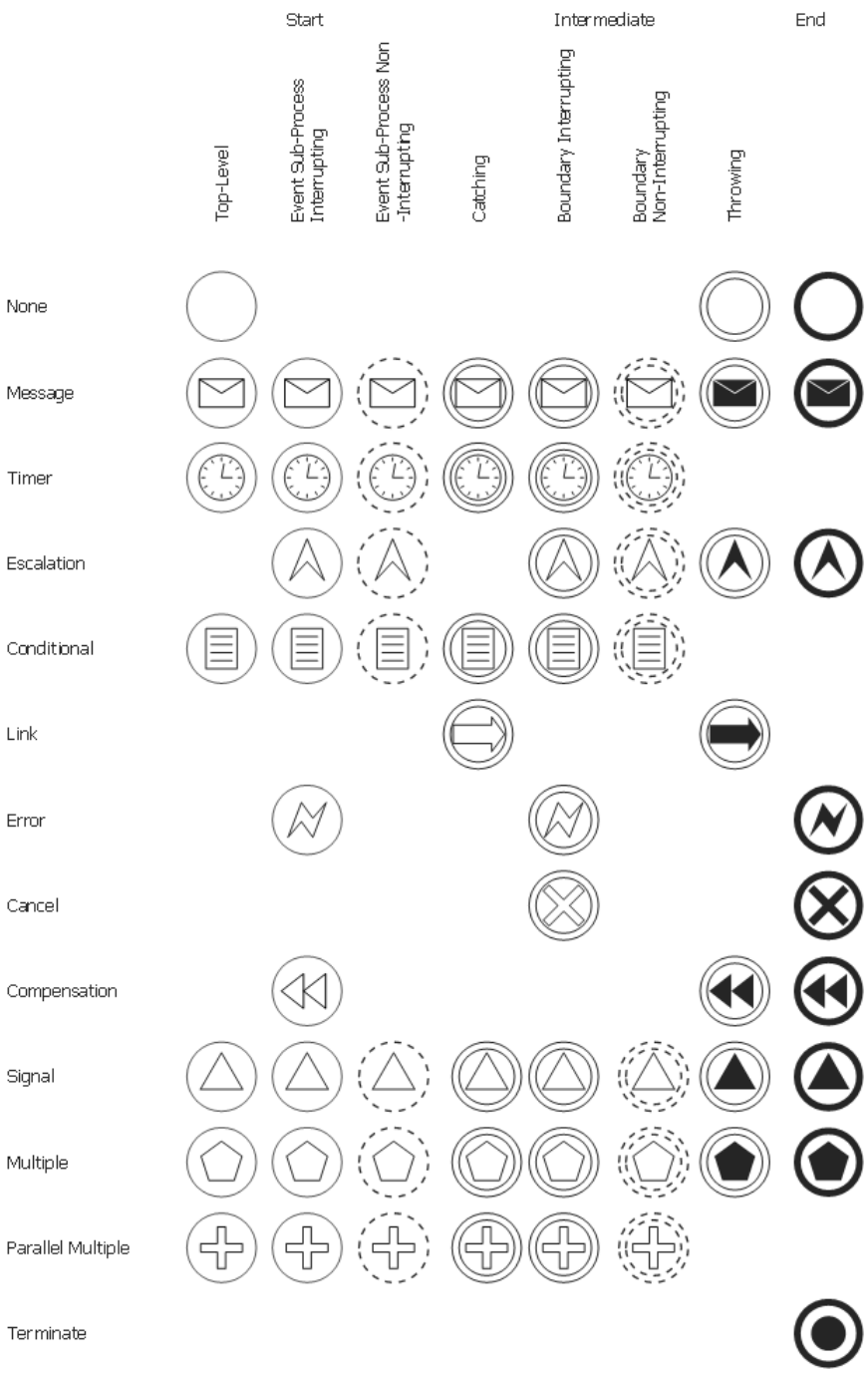

Figure 2.3: Events BPMN 2.0 - Fonte: ConceptDraw

Activities

Activities are process steps that show how a process runs in your workflow. Activity representation is often viewed as a relationship between business model concepts, associating the process with organizational functions and units, business objects, objectives, and events.

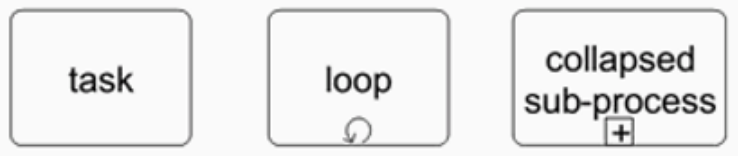

Figure 2.4: Activities BPMN 2.0

Gateways

A gateway is used to control the divergence or convergence of sequence streams. This will determine the branching, binding, and joining paths. Symbols incorporated into graphic notation indicate the type of control.

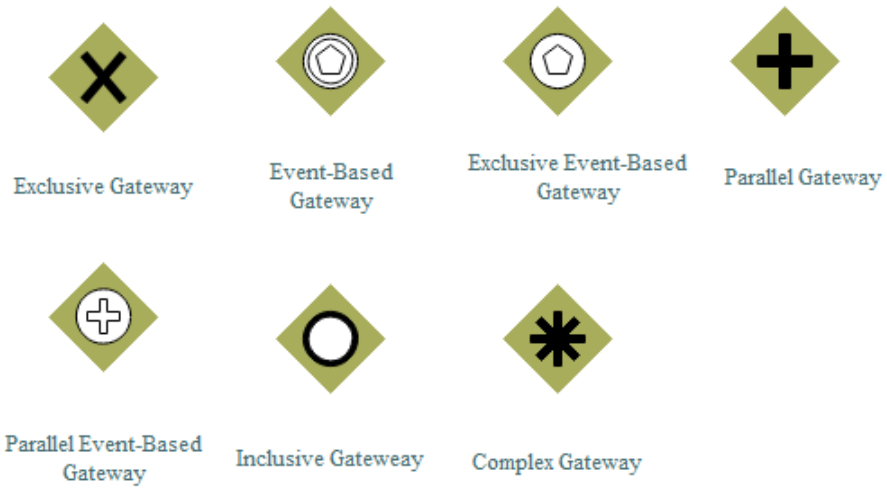

Figure 2.5: Gateways BPMN 2.0 Fonte: EDrawSoft

2.2.2 Connecting Objects

Flow objects are connected to the diagram by connection objects to create the basic structural skeleton of a business process. There are four basic types of objects to provide this function: sequence flow, message flow, association, and conditional flow.

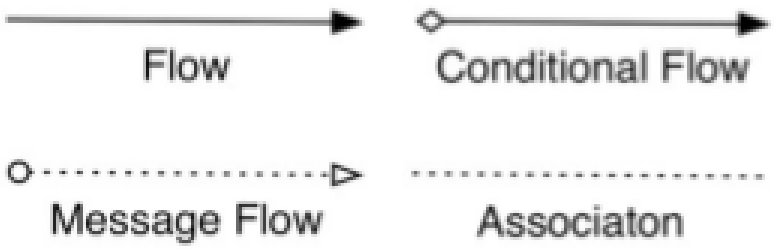

Figure 2.6: Fonte: Researchgate - Connecting Objects BPMN 2.0

Sequence flow is used to indicate the order in which activities are performed in a process.

Message flow is used to show the exchange of messages between two participants in the process. In BPMN, two separate Pools in the diagram represent two participants.

Association is used to associate information with stream objects. Flowing graphic or textual objects can be associated with flowing objects.

Conditional streams are sequence streams that take precedence under certain conditions. The default flow represents the common sequence flow that must be followed if no conditions are met. Conditional flow is followed only under special circumstances. The conditional flow must have a label that describes its condition.

2.2.3 Swimlanes

Swimming nets help to divide and organize activities into different visual categories in a diagram to illustrate different functional capabilities or responsibilities. This category is supported by BPMN through two element types: pool and lane.

Pools are "compartments" where flow elements are accommodated to indicate that the participant or process is performing each activity. A participant is defined as a general

Figure 2.7: Swimlanes BPMN 2.0

business rule (for example, a buyer, seller, supplier) or as a specific business entity, such as a company. Each pool represents a distinct process and each participant has its own pool.

Lanes are elements placed in sets to indicate more than one profile that contributes to the execution of a process. Lanes create subpartitions for objects within a pool. These partitions are used to group process elements. They usually represent organizational rules, but can represent any desired classification.

2.2.4 Artifacts

Artifacts are extra elements that may appear inside, but do not alter the flow or perform tasks. They serve as representations that increase the clarity of the diagram or expose certain relevant points in the process and are defined by three basic types: data objects, groups, and text annotations.

Data Objects

Represents data entered into the process, data resulting from the process, data that needs to be collected, or data that must be stored.

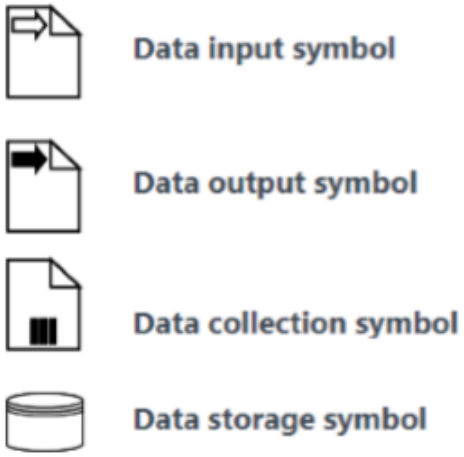

Figure 2.8: Data Objects BPMN 2.0

Groups

A group of activities that do not affect sequence flow. Grouping may be performed for analysis or documentation purposes. Groups can also be used to identify activities of a distributed transaction that is displayed between Pools.

Figure 2.9: Groups BPMN 2.0

Text Annotations

Allow the modeler to describe additional flow parts of the model or notation.

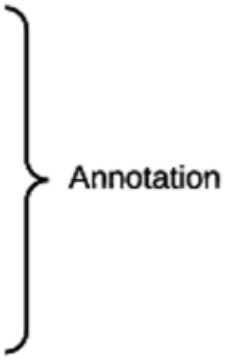

Figure 2.10: Text Annotations BPMN 2.0

Example

The following is an example of how all of these elements work together to make the business process model look at the entire real world process. As shown in the figure 2.11.

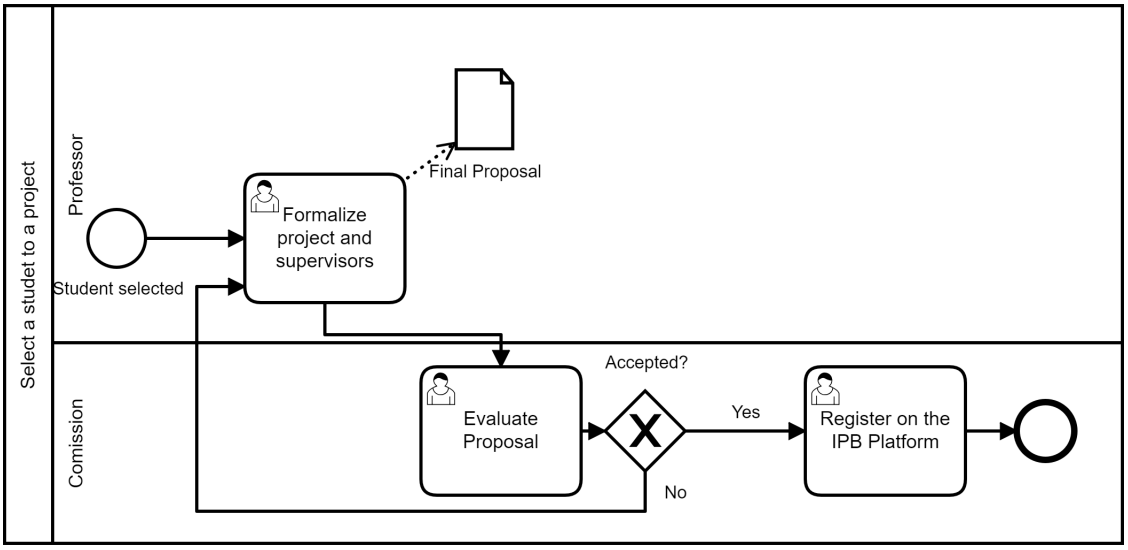

Figure 2.11: Example model using BPMN 2.0

In this example we can see activities, artifacts, connecting objects, lanes, pools, events, gateways. Showing the functions of each person in the lane.

This model is a representation of a process where the professor send to the scientific commission a project containing the description of it and the student who will develop

the project. After, the commission should approve this project or ask a reformulation. If the project is accepted, the commission should register the project on the IPB online platform, if it isn't the professor should reformulate the project and send again.

With a model like this, we can execute this model as a instance of a process, but, to do that we should have a BPMS, and this one is explained in the next section.

2.3 Business Process Management Systems

Today, the field of BPM is becoming increasingly recognized as an established field of applied research and practice [7].

As they seek to be more competitive, organizations are now shifting their focus to processes that cannot be easily replicated by competitors, and its main ingredients are human knowledge, experience and creativity. This, in turn, creates the need to support these intensive processes with a lot of knowledge.

According to [2] the BPMS have the following features: Process modeling, workflow modeling, rule definition, business operation simulation, process automation, business operation, performance tracking, activity monitoring and control. It should provide a business environment that integrate the business and the Information Technology (IT).

BPMS automate core BP from "end to end." That means a good BPMS has the tools and technologies to include human-focused tasks along with machine processing applications, to allow a company or organization to flexibly manage its work. BPMS also include reporting and charting capabilities to permit end users and managers to understand the process and response times of the BP. BPMS is the technology that implements BPM.

In the process modeling phase, software tools have demonstrated great value and have been used to facilitate modeling, documentation and integration between the models. According to [8], it is desired that the modeling tools have the following characteristics:

- Facility for process drawing

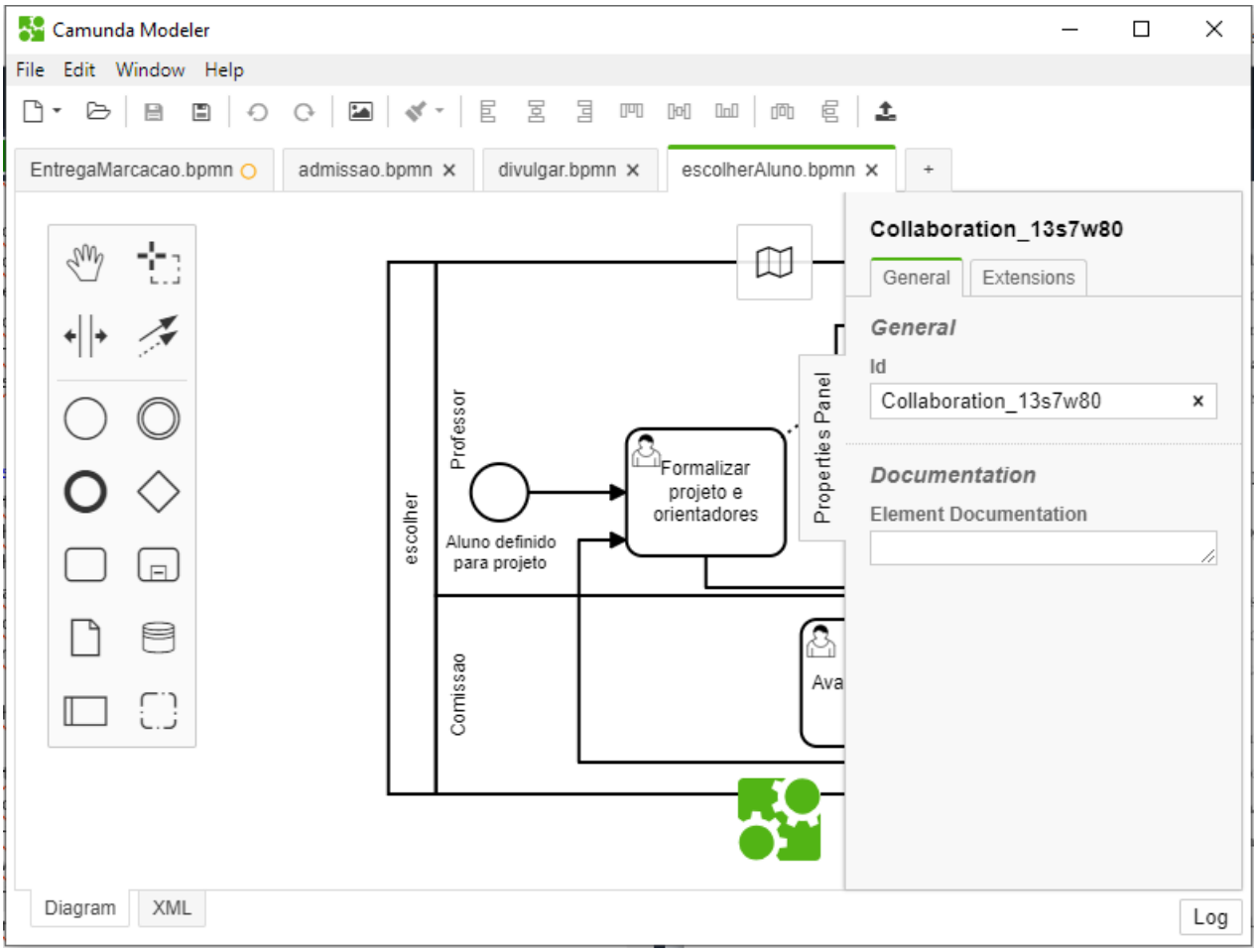

Figure 2.12: Camunda - Example of BPMN modeler

- Use standard symbology notation
- Possibility to collaborate in drawing
- Possibility to attach information to the activities (business rules, costs, systems, generated documents, etc.)
- Integration with database and external systems

According to [2] applications can be generated and tested along with interfaces to link software with the BPMS. They are then put into production to support business operations presented in the flow mapping and rules that define their logic.

Chapter 3

Survey on BPMN tools

In order to provide us with a tool that could support the project requirements, it was necessary to search among the various options available in the market. The main idea was to make a comparison between existing free distributions of BPMS, using some metrics that appear in some similar cases. To validate the comparison, in addition to the characteristics of the literature, some were created regarding our processes and requirements, all of it is shown in the next chapter 4. All characteristics are described in the next section along with the source and type of comparison made, qualitative or quantitative.

3.1 Introduction

As mentioned before, the research was based on other studies that also compared BPMS and evaluated some points. The evaluation points are:

1. Facility for process drawing - Qualitative

   This item is based in [8], and, how the name says, is trying to evaluate if the tool have an amicable interface to draw processes models

2. Possibility to attach information to the activities (business rules, costs, systems, generated documents, etc.)

This item is also based in [8], and, how the name says, is trying certificate if is possible to attach some information to the activities

3. Integration with database and external systems - Qualitative

   This item is also based in [8], and, how the name says, is trying to certificate if the tool implements some methods to communicate with external systems and Database (DB)s.

4. User Interface - Qualitative

   This item is based in [9], and, how the name says, is trying to evaluate the user interface of the tool

5. User Experience - Qualitative

   This item is also based in [9], and, how the name says, is trying to evaluate the user experience, like the facility to find the features and the usability of the tool

6. Process Simulation and Execution - Qualitative

   This item is also based in [9], and, how the name says, is trying to measure if the tool allow the user to simulate and execute the processes

7. Dynamic form editor for the human tasks - Qualitative

   This item is based in [10], and, how the name says, is trying to measure if the tool allow to use forms for the human tasks

8. Support of the modeling guidelines - Qualitative

   This item is based in [11], and, is trying to measure if the tool guides the modeling with the BPMN standards. The intention is evaluate if the tool help to create a model in the right way.

9. Use standard symbology notation - Quantitative

   This item is also based in [8], and, how the name says, is trying to certificate if the tool uses the standard symbology and notation DBs.

10. Possibility to collaborate in drawing - Quantitative

    This item is also based in [8], and, how the name says, is trying to certificate if the tool allows the users to collaborate in the drawing process.

11. Compatible With Linux - Quantitative

    This item is also based in [9], and, how the name says, is trying certificate if the tool is compatible with Linux

12. Compatible With Windows - Quantitative

    This item is also based in [9], and, how the name says, is trying to measure if the tool is compatible with windows

13. Compatible With WEB - Quantitative

    This item is also based in [9], and, how the name says, is trying to measure if the tool is compatible with WEB

14. Installation file size* - Quantitative

    This item is also based in [9], and, how the name says, is trying to measure if the installation file size of the tool

    *File Size can vary because some tools have separated modeler and the engine to execute the processes

15. Group and user definition - Quantitative

    This item is also based in [10], and, how the name says, is trying to measure if the tool allow to create groups and users definitions, in this way providing the stuff to map and execute processes in the right way

16. Process version control - Quantitative

    This item is also based in [10], and, how the name says, is trying to measure if the tool allow to control the versions of the processes, which means, if the tool allow to update a model and save the previous versions

3.1.1 Goals and evaluation criteria selection to the survey

The main goal of this survey is find a tool that fit in our needs, and to do that we will compare the tools considering the most important features being:

- Be compatible with most of the platforms
- Allow integrating with external systems and DBs
- Allow executing and simulating processes
- Use standard symbology and notation
- Installation file size
- Groups and Users definitions
- Process version control

With these features we can find a tool that can maintain and execute the BPs and BPMN models, and, how our system is not only based in processes, will be better use a tool that provides an Representational State Transfer (REST) Application Programming Interface (API) to be integrated in a external system, i.e, we are looking for a tool that can provide a way to execute the processes from an external application, and this application will contain all the core execution, and the maintenance of the process will be in charge of the tool.

3.1.2 Selection of the Tools for the Survey

BPM tools are used to design a systematic approach to optimize business processes. They are used to modeling, implement, and automate business workflows with the goal of improving corporate performance by minimizing errors, inefficiencies, and miscommunication.

The problem with BPM tools is that it can be difficult to find something suited for your use. Online BPM tools are usually paid for and it is not easy to find something suitable for your use cases.

Many tools have been selected to be evaluated, but, for many reasons, some of them caused problems and were excluded of the survey, in this way these are the tools chosen to be evaluated:

1. BizAgi Process modeler
2. Bonita Soff
3. jBPM
4. Heflo
5. BeePMN
6. Camunda

3.2 Results

In this section, the results obtained with the survey are shown, and, to make easier to read the results, a table with all the features is at the Appendix B.1.

3.2.1 BizAgi Process modeler

Bizagi Modeler is a paid modeling tool but with a free version that can be downloaded and can use this until you want to create an automated application, otherwise, no investments are required. The tool is totally based on BPMN, and allow modeling using a drag and drop environment, that makes easier to create diagrams. In addition, there is a knowledge base with a lot of posts about errors and hints to support the users to get the most out of the tool.

To support users a community was created, nowadays that community have many expert members whom you can share your ideas, collaborate and get collaboration in your projects. The tool provides a service to create an interaction between business and IT. The modeler also support importing files of .bpmn or .xpdl extension or files created with Microsoft Office Visio, there is also a function to export models for these formats or many image formats like .png or .jpg.

There are many advantages, but we can list many disadvantages, and one is that the software was built only for windows and must have it to use, another disadvantage is that the software is a little big (800 MegaByte (MB) just for the modeler, to execute processes the installation of the BizAgi BPMS is necessary.

The modeler is very easy to use, how you can see in the figure 3.1, and contain many features to do the use more practical and to help the user to create a good model and test it too.

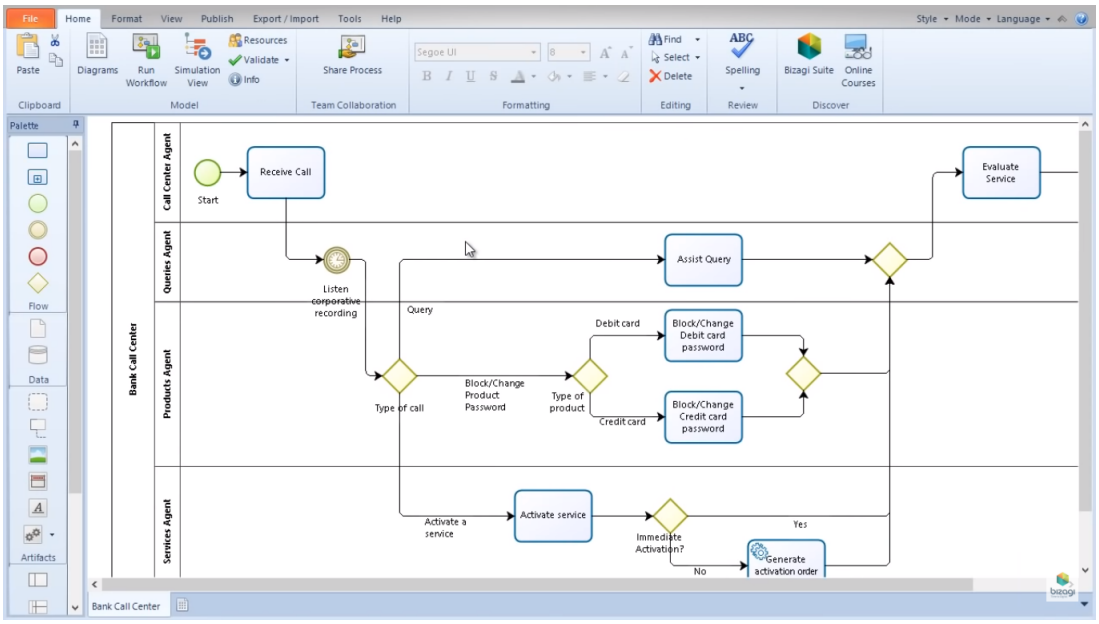

Figure 3.1: Fonte: BizAgi WebSite - BizAgi

BizAgi Survey Results

The first tool evaluated was BizAgi, and the results are following. First the results about the Qualitative features measured, and after, in the table 3.1 are the results about the Quantitative features of the survey.

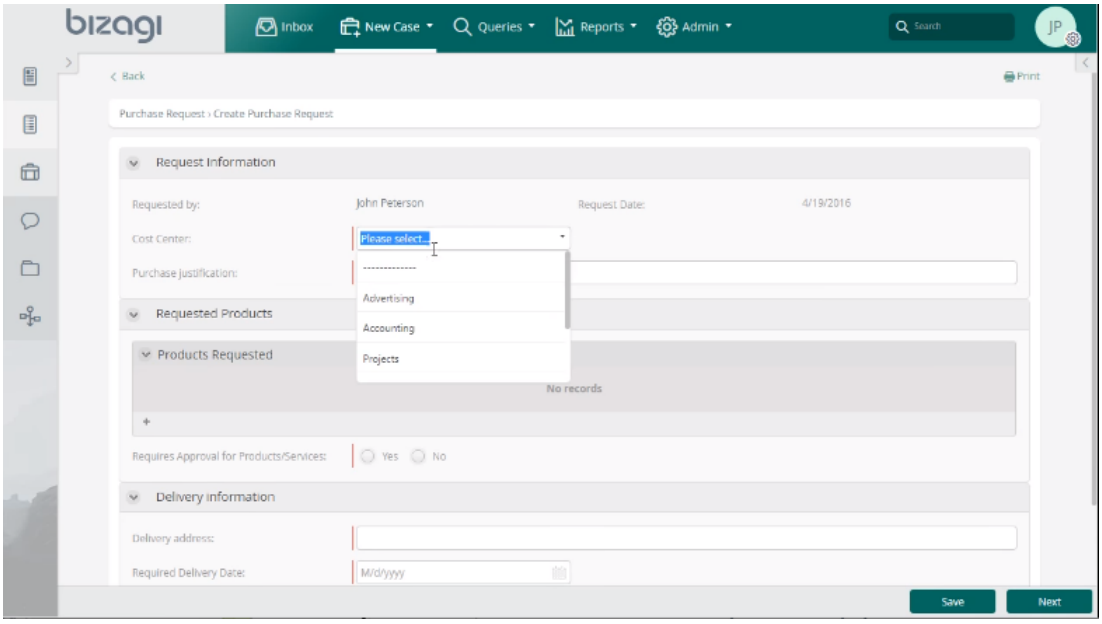

Figure 3.2: Fonte: BizAgi WebSite - BizAgi Studio

1. This tool help a lot the user to make diagrams and also helps to validate them, the tool have a left panel with all the BPMN elements, and you can just drag and drop it.

2. This tool allows the user to attach information in the activities, can input files with fields to be filled.

3. This tool does not allows the user to integrate with external DB, and all the execution and information occur and are stored in the web application

4. This tool has an friendly interface to the user, because its design use the standard BPMN symbology.

5. This tool provides a good user experience, due the good interface, and to the way the functions are disposed, everything have a good affordance applied and it makes the process (from model to deployment) easy to be mapped.

6. This tool allows user to simulate and execute instances of processes

7. This tool has an interface to create pages where you can map the interaction between all groups (roles) involved in the process

8. This tool provides a way to validate the models, but not like [11] describes in their work, so in this way we assume that the tool do not support the modeling guidelines

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Yes	Yes	No	Yes	No	800 MB	Yes	Yes

Table 3.1: BizAgi Survey Results

3.2.2 Bonita Soft

Bonita BPM Studio is a graphical environment for creating processes, applications, data models, and user views (pages and forms).

The results are following. First the results about the Qualitative features measured, and after, in the table 3.2 are the results about the Quantitative features of the survey.

1. This tool help a lot the user to make diagrams and also helps to validate them, the tool have a left panel with all the BPMN elements, and you can just drag and drop it.

2. This tool allows the user to attach information in the activities, can input files with fields to be filled.

3. This tool does not allows the user to integrate with external DB, and all the execution and information occur and are stored in the web application

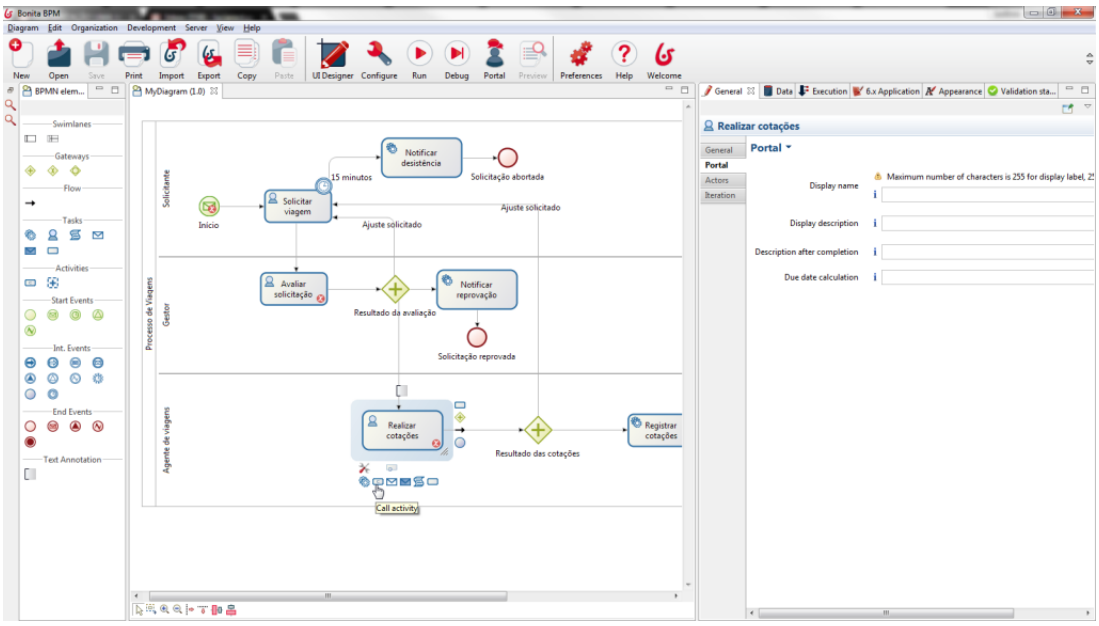

Figure 3.3: Fonte: Bonita Soft - Bonita Soft Modeler

4. This tool has an amigable interface to the user, because its design use the standard BPMN symbology.

5. This tool provides a good user experience, due the good interface, and to the way the functions are disposed, everything have a good affordance applied and it makes the process (from model to deployment) easy to be mapped.

6. This tool allows user to simulate and execute instances of processes

7. This tool has an interface to create pages where you can map the interaction between all groups (roles) involved in the process

8. This tool provides a way to validate the models, but not like [11] describes in their work, so in this way we assume that the tool do not support the modeling guidelines

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Yes	Yes	Yes	Yes	No	500 MB	Yes	Yes

Table 3.2: Bonita Soft Survey Results

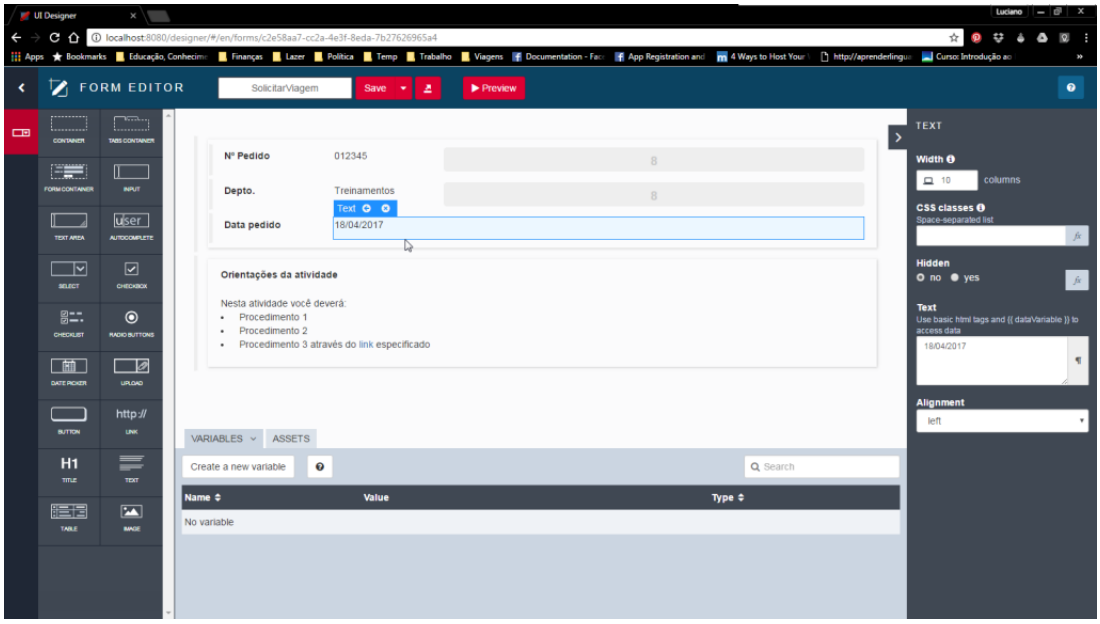

Figure 3.4: Fonte: Bonita Soft - Bonita Forms to Processes

3.2.3 jBPM

jBPM is a toolkit for building business applications to help automate business processes and decisions.

The core of jBPM is a light-weight, extensible workflow engine written in pure Java that allows to execute business processes using the latest BPMN 2.0 specification. It can run in any Java environment, embedded in your application or as a service.

The results are following. First the results about the Qualitative features measured, and after, in the table 3.3 are the results about the Quantitative features of the survey.

1. This tool help a lot the user to make diagrams and also helps to validate them, the tool have a left panel with all the BPMN elements, and you can just drag and drop it.

2. This tool allows the user to attach information in the activities, can input files with fields to be filled.

3. This tool does not allows the user to integrate with external DB, and all the execution and information occur and are stored in the web application

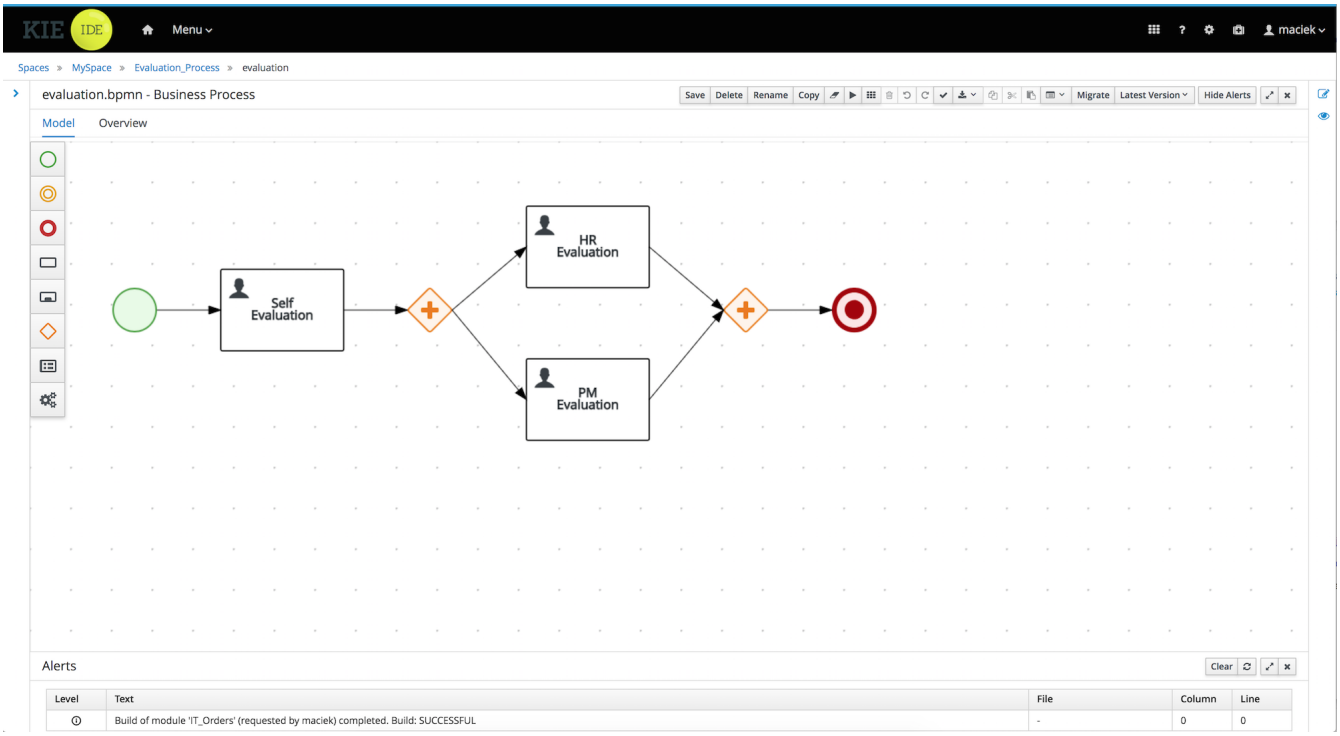

Figure 3.5: Fonte: jBPM Application - jBPM Modeler

4. This tool has an amigable interface to the user, because its design use the standard BPMN symbology.

5. This tool provides a good user experience, due the good interface, and to the way the functions are disposed, everything have a good affordance applied and it makes the process (from model to deployment) easy to be mapped.

6. This tool allows user to simulate and execute instances of processes

7. This tool has an interface to create pages where you can map the interaction between all groups (roles) involved in the process

8. This tool provides a way to validate the models, but not like [11] describes in their work, so in this way we assume that the tool do not support the modeling guidelines

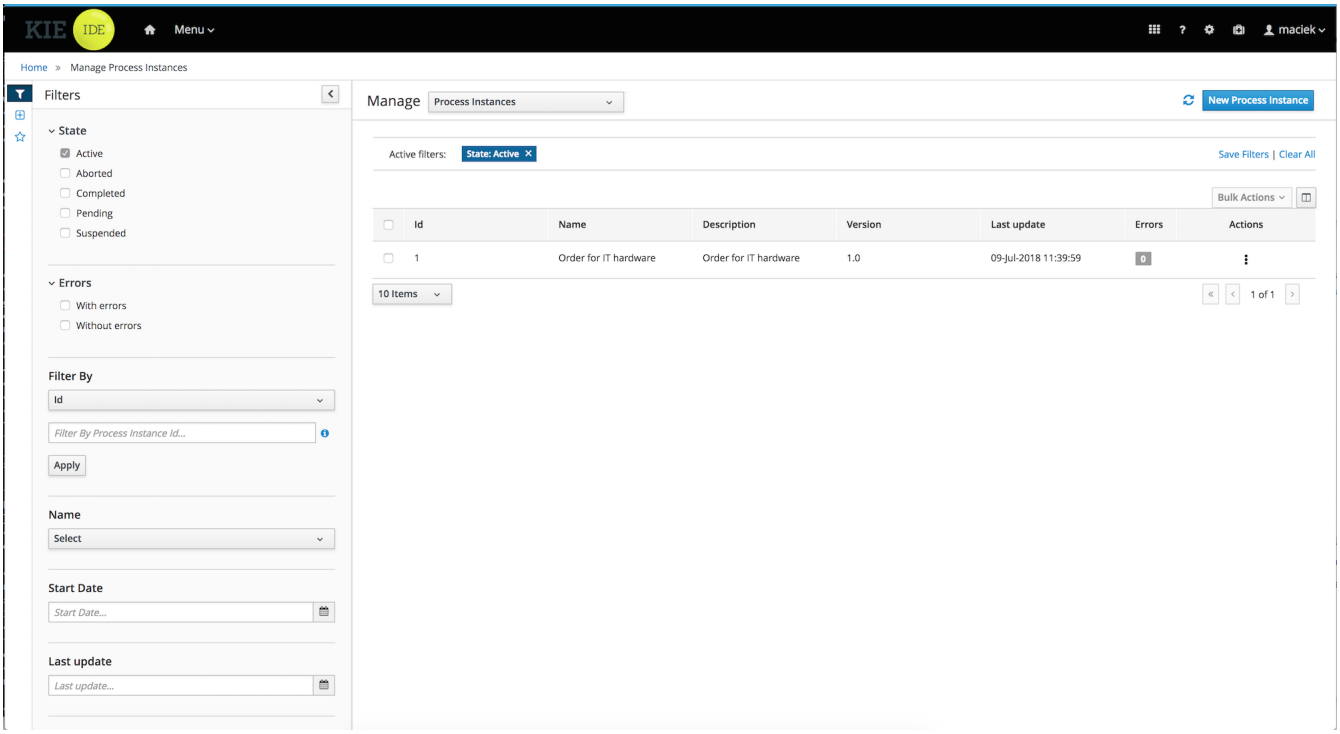

Figure 3.6: Fonte: jBPM Application - jBPM Execution

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Yes	Yes	Yes	Yes	Yes	250 MB	Yes	Yes

Table 3.3: jBPM Survey Results

3.2.4 Heflo

HEFLO is an online tool for modeling, documentation, and publication of business processes. In addition to modeling, it allows to document and share the processes in a portal, you can also share your models with viewers, that can suggest improvements, changes or just make comments about the models, it can be done easily using the feedback tab of the modeler. To support and assist users, there are many features like videos and texts about the BPMN, processes automation, and some guides to modeling. The tool supports importing files of .bpmn extension and exporting for .bpmn, image, Portable Document Format (PDF) or to create documentation that contains the description provided in the diagram. There is a free plan for students, that provides access to features of paid plans like add collaborators or upload attachments to the diagram, also, to improve security, there is a version control functionality.

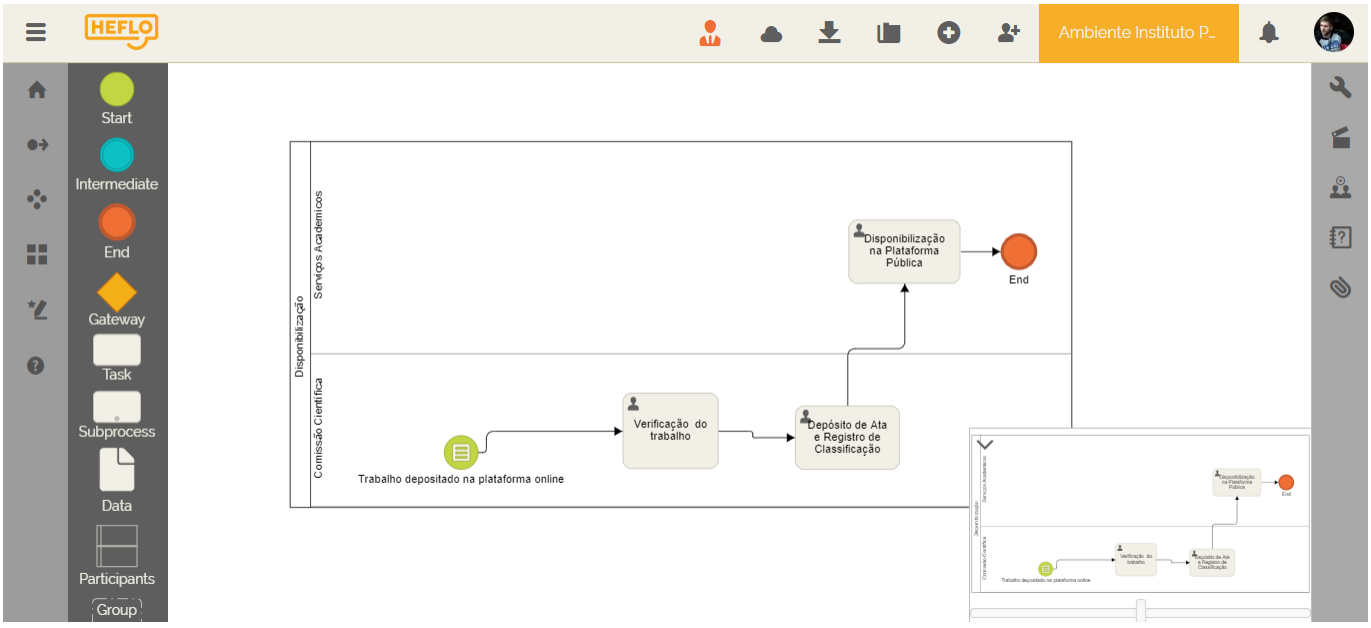

Figure 3.7: Fonte: Heflo Website - Heflo Modeler

The results are following. First the results about the Qualitative features measured, and after, in the table 3.4 are the results about the Quantitative features of the survey.

1. This tool help a lot the user to make diagrams and also helps to validate them, the

tool have a left panel with all the BPMN elements, and you can just drag and drop it.

2. This tool allows the user to attach information in the activities, can input files with fields to be filled.

3. This tool does not allows the user to integrate with external DB, and all the execution and information occur and are stored in the web application

4. This tool has an amigable interface to the user, because its design use the standard BPMN symbology.

5. This tool provides a good user experience, due the good interface, and to the way the functions are disposed, everything have a good affordance applied and it makes the process (from model to deployment) easy to be mapped.

6. This tool allows user to simulate and execute instances of processes

7. This tool has an interface to create pages where you can map the interaction between all groups (roles) involved in the process

8. This tool provides a way to validate the models, but not like [11] describes in their work, so in this way we assume that the tool do not support the modeling guidelines

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Yes	Yes	No	No	Yes	0 MB	Yes	Yes

Table 3.4: Heflo Survey Results

3.2.5 BeePMN

The results are following. First the results about the Qualitative features measured, and after, in the table 3.5 are the results about the Quantitative features of the survey.

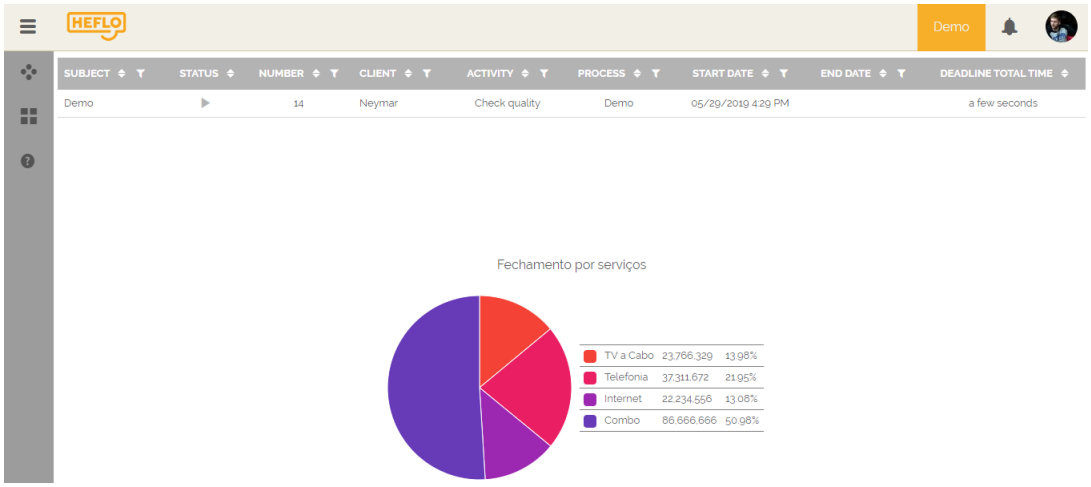

Figure 3.8: Fonte: Heflo WebSite - Heflo Process Execution

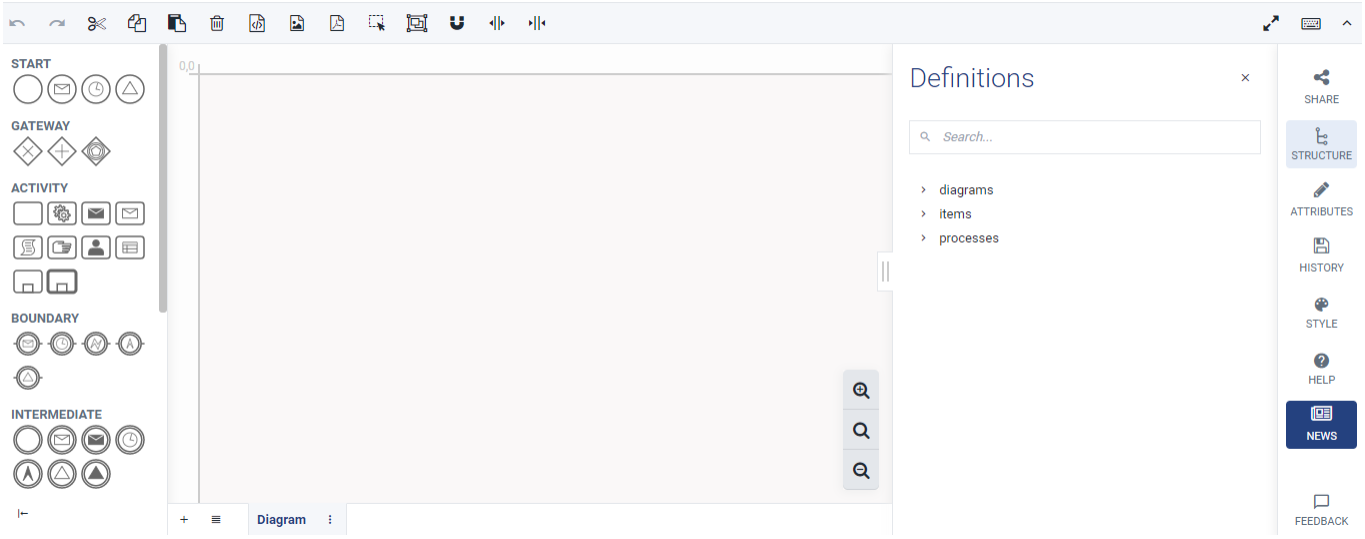

Figure 3.9: Fonte: BeePMN WebSite - BeePMN Modeler

1. This tool help a lot the user to make diagrams and also helps to validate them, the tool have a panel with many of the BPMN elements, and you can just drag and drop it.

2. This tool allows the user to attach information in the activities, can input files with fields to be filled.

3. This tool does not allows the user to integrate with external DB

4. This tool has a good interface to the user, because its design use the standard BPMN symbology, but some elements are missing in the first look, you should search a little to find some features.

5. This tool provides an user experience that regular, due the little failures in the interface, and to the way of interaction with the tool, some parts have a good affordance applied and it makes the process easy to be mapped.

6. This tool allows user to simulate and execute instances of processes, but its not a easy task to be made, many configurations should be done before the execution starts

7. This tool has an interface to create pages where you can map the interaction between all groups (roles) involved in the process

8. This tool provides a way to validate the models, but not like [11] describes in their work, so in this way we assume that the tool do not support the modeling guidelines

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Yes	Yes	No	No	Yes	0 MB	Yes	Yes

Table 3.5: BeePMN Survey Results

3.2.6 Camunda

Camunda is a light-weight BPMS whic is divided into a server (engine) to maintain and execute the processes and a modeler used to create the models and deploy it to the server.

The server is made in Java and have a god REST API implemented, what facilitate the integration of the processes execution with external systems.

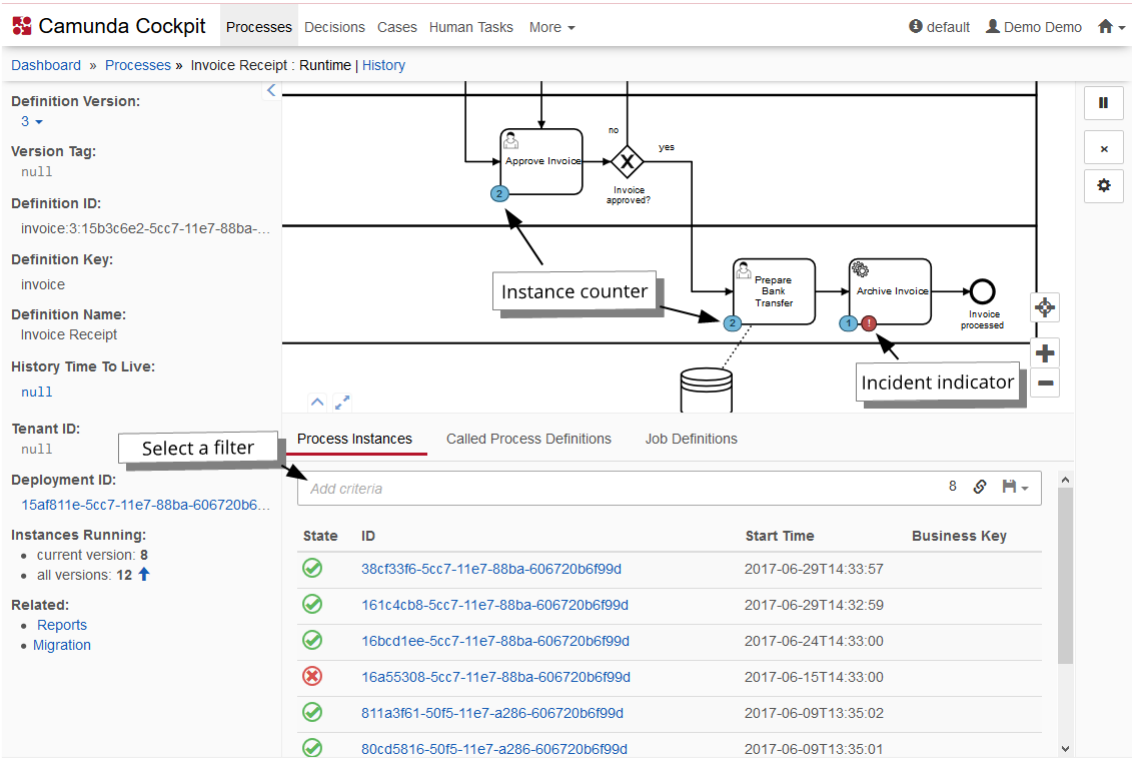

Figure 3.10: Fonte: Camunda Server - Camunda Processes

The results are following. First the results about the Qualitative features measured, and after, in the table 3.6 are the results about the Quantitative features of the survey.

1. This tool help does not help the user to make diagrams but it helps to validate them, the tool have a panel with all of the BPMN elements, and you can just drag and drop it.

2. This tool allows the user to attach information in the activities, input files with fields to be filled, DBs, etc.

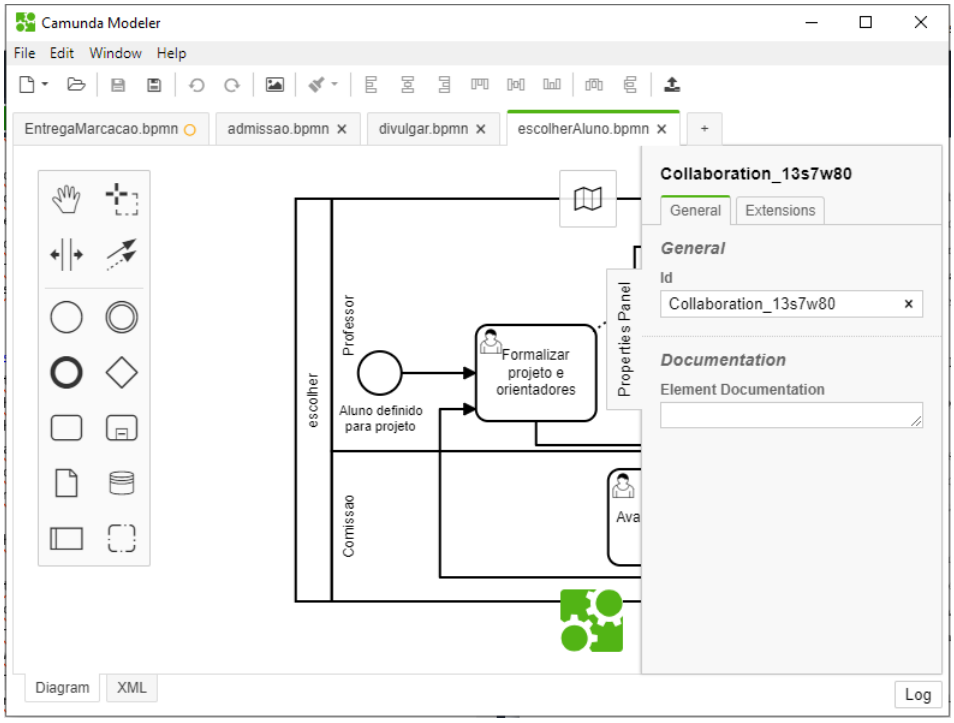

Figure 3.11: Fonte: Camunda Modeler - Camunda Modeler

3. This tool allows the user to integrate with external DBs and external systems too

4. This tool has a good interface to the user, because its design use the standard BPMN symbology.

5. This tool provides a good user experience, due the modeler be a separated and ofline tool, with an good interface, and to the way of interaction with the tool have good affordances applied and it makes the process easy to be mapped and deployed to the server.

6. This tool allows user to simulate and execute instances of processes

7. The tool allow to map the required fields in each task and create forms inside the application

8. This tool provides a way to validate the models, but not like [11] describes in their work, so in this way we assume that the tool do not support the modeling guidelines

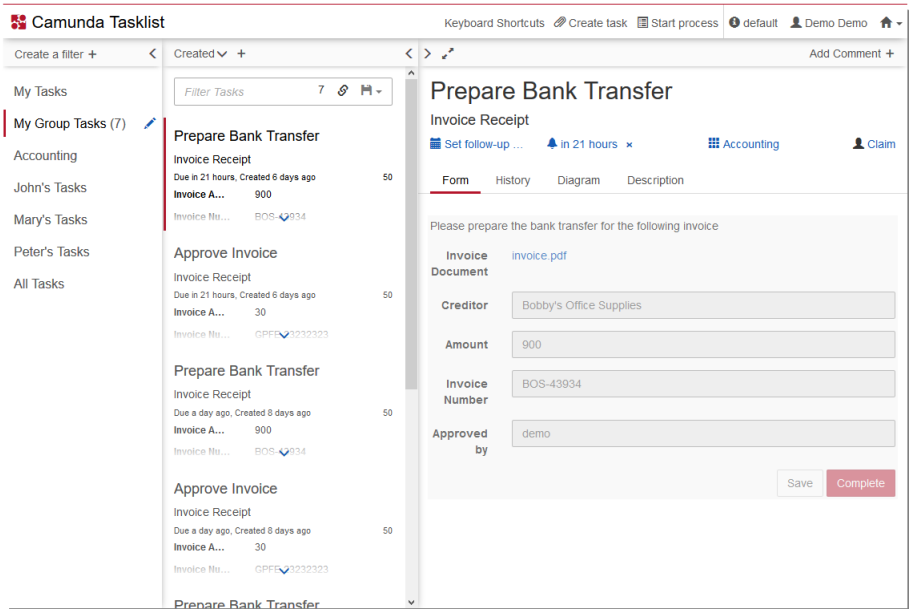

Figure 3.12: Fonte: Camunda Server - Camunda Forms

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Yes	Yes	Yes	Yes	No	230 MB	Yes	Yes

Table 3.6: Camunda Survey Results

3.3 Conclusion

At the end of the analysis we can see that most of the tools analyzed are very good, especially regarding the modeling part, as they all met the specifications of BPMN 2.0.2. Another thing that drew attention was that most did well on the most important points in the selection. Thus, the choice was due to other factors that are pertinent to the software development project, which is the possibility of communication with an external system and the available platforms.

As stated above, one of the points that was taken into consideration was the available platforms, because we were looking for some tool that could give us independence, that is, that would not depend on external company servers. At this point Heflo and BeePMN have already been discarded because they are online and stored on private servers. Another factor that was highlighted was how much of the tool was needed to use for the software project, that is, the tool can offer only one service or to use a part is necessary to have the whole tool. At this point Bonita Soft and Bizagi were discarded, leaving only jBPM and Camunda.

About these two, both were very similar, as they were compatible with the requirements and offered a good solution to the problem. The choice was due to the factor already mentioned above and the ability to communicate with external systems, and in this regard, the camunda contained a well-documented implemented REST API, which facilitates all development work, since jBPM has In most cases, paid documentation with difficult to access.

So the tool selected is Camunda to be used in the development of the project.

Chapter 4

The System

The main objective of the project is to create a software system where all requirements and processes could be executed, and that this system had an interface in order to facilitated some actions and maintenance of some processes.

Thus, the best way that was found to make this happen is described below, in the topics that represent the phases of the software development project, which are the software design, the necessary database design, the process modeling. , environment installation and deployment.

4.1 Introduction

Throughout the project, the work was done with the intention of being able to gather the necessary characteristics for the software project, thus, all the previously mentioned parts have influence on the result obtained and disposed in this chapter.

Here in this chapter, is contained the description of the software and its functionalities, showing which use cases were obtained, which actors interacting with the system is made, as well as the technological architecture employed for development is also explained and described, having the whole process of installation of the basic requirements for operation and configuration demonstrated. In this chapter are also arranged the final results obtained, ie the software.

4.2 Project

In order to organize the implementation of the software and gather all the reunited information, a software project was created. In this software project some features are included, like the description of the processes and the model created to each process, the use case diagram, containing both processes and software requirements, the software architecture, the way of use of the BPM ENGINE and final the installation and configuration of the of the environment necessary to the software.

4.2.1 System Requirements

This section presents all the requirements that were stipulated throughout the project. These requirements include various day-to-day activities of the course director, as well as others that can help him organize better with schedules and events of the course.

The requirements described in this chapter were obtained initially by a list of tasks that the director had to do along the weeks and other processes described below are from the regulation of the course.

Initially a requirements list was created, and in this list were contained the requirements that had no process connection, these requirements are all linked to the director function and in this way, the Director is the first (and main) role of the system. Some of these tasks are to analyze some student data for enrolled subjects and subjects to learn how things are going in the classroom. The same is true for professors, to know how many classes they have already taught, how many students are enrolled in each subject and what is the average frequency of students in the respective professors' disciplines. Other tasks that have been listed are organizing the event calendar and course study visits.

Analyzing all the documents and tasks, like described before, the list of requirements obtained is following:

- Requirement 1 - Possibility to view the list of students by year and subject:

director could see the list of students by year and subjects, and also see their subjects, frequency, detailed information (email, name, start year, semester).

- Requirement 2 - List of professors by subject:

  director could see the list of professors by subjects, and also see the subject details, like the enrolled students, their frequency, the scheduled tests, classes given, details of the professor (email, name) .

- Requirement 3 - Professor attendance schedule:

  Director could see the professors attendance schedule, i.e, professors have some points of attendance during the week, and the director should be able to see these points.

- Requirement 4 - Access to student frequency for all subjects:

  Director should be able to see all the frequency numbers of all the students and all subjects they are enrolled.

- Requirement 5 - Schedule events and study visits:

  Director should be able to create and maintain events and study visits in the system. To create both some attributes should be given like name, description, place, date.

- Requirement 6 - Test dates of the various subjects throughout the semester:

  Director should be able to see all the test points of all the subjects during the semester.

- Requirement 7 - Course Commission List:

  Director should be able to create, view and maintain the Course commission list

- Requirement 8 - Assignment of projects / dissertations:

  The assignment of projects to students should be facilitated by the system

- Requirement 9 - List of Companies:

  Director should be able to maintain a list of companies that are partners to the IPB or the course

- Requirement 10 - List of projects under development and their advisors:

  The system should show a list of projects that already started to be developed and their advisors

- Requirement 11 - History of completed projects:

  The system should show a list of projects that have already been presented and are completed now

These requirements are the final ones and after these requirements, the processes that needed to be mapped were studied and their description is next in the next topic.

4.2.2 Processes

In this topic, some processes related to the course are described. All of these processes are in the Masters in Information Systems regulation, and most of them are related to the final project of the course and can represent some requirement of the first list, and, to represent all the process in the right way, some more roles were created and mapped to the system.

Admission of Proposals

The first process described is the admission of proposals, and it is the process where professors and the scientific commission interact so that they can define if a proposal fits in what is expected for a project. This process goes through the stages of proposal creation, evaluation, and, submission on the platform and the steps to complete this process are:

1. Professor creates a proposal of project and send to be evaluated

2. Scientific commission evaluates the proposal and accept it or not (if not, professor should reformulate the proposal and start the process again)

3. Scientific commission submits the proposal to the IPB online Platform

Divulgation of Proposals

The second process described is the divulgation of proposals. Divulgation of Proposals process, is the process where the scientific commission, after accept a proposal, starts the divulgation of it, in this way, a student can be easily found to start the development of a project. This process starts when a proposal is accepted and ends if the proposal starts to be developed or if the scientific commission reevaluate the proposal and decide to close it.

1. Starts to divulgate a proposal

2. A professor select a student to develop the proposal

3. Scientific commission stop the divulgation of the proposal

4. If a proposal rest in divulgation too much time, scientific commission should reevaluate the proposal and decide to maintain or not it

Select the Student for Project

Select the Student for Project process, is the process where the professor, after defines a student to develop the project, the professor should write a project with the supervisors and the student and send it to the commission, the commission, in his part, should evaluate the project proposal and accept it or ask for a reformulation. This process starts when a proposal is assigned to a student and ends if the commission accept the project to be developed.

1. Professor selects a student to develop a proposal

2. Scientific commission evaluates the proposal of project (with a student) and accept it or not (if not, professor should reformulate the proposal and start the process again)

3. Scientific commission submits the project to the IPB online Platform and the development starts.

Select Board and Schedule Public Discussion

Select Board and Schedule Public Discussion of the final work, is where an evaluating board to judge the methods and results obtained of a final work is selected, in this part some steps are necessary, such as the definition of the board members, the place and date of the public discussions and a previous evaluation of the project.

1. Scientific commission receives a final project and have to select a judging board to the project

2. The judging board should read and accept it or not (if not, student should reformulate the project and present the final version within 30 days)

3. Scientific commission schedule the public discussion

After analyzing the requirements, whether process or normal, it was found that the application has a dependency on a BPM engine to execute its processes. But this dependency is not the main part of the project, and most of the other requirements do not depend on a BPM, so the choice of tool aims to find a solution where you can execute processes in an external application and maintain be made by ENGINE BPM.

4.2.3 Business Processes Models

A process can be defined as a set of recurrent or periodic activities that interact to produce a result. In this topic, the modeled processes are shown, and a little explanation about the logic and the goals of each one is given.

All of these process were obtained in the regulation of the Masters in Information Systems, and to make it easier to understand, this regulation is the document that contain the rules to manage the course.

Admission of Proposals

Proposals Admission process (figure 4.1), where professors and the scientific commission interact so that they can define if a proposal fits in what is expected for a project. This process goes through the stages of proposal creation, evaluation, and, submission on the platform.

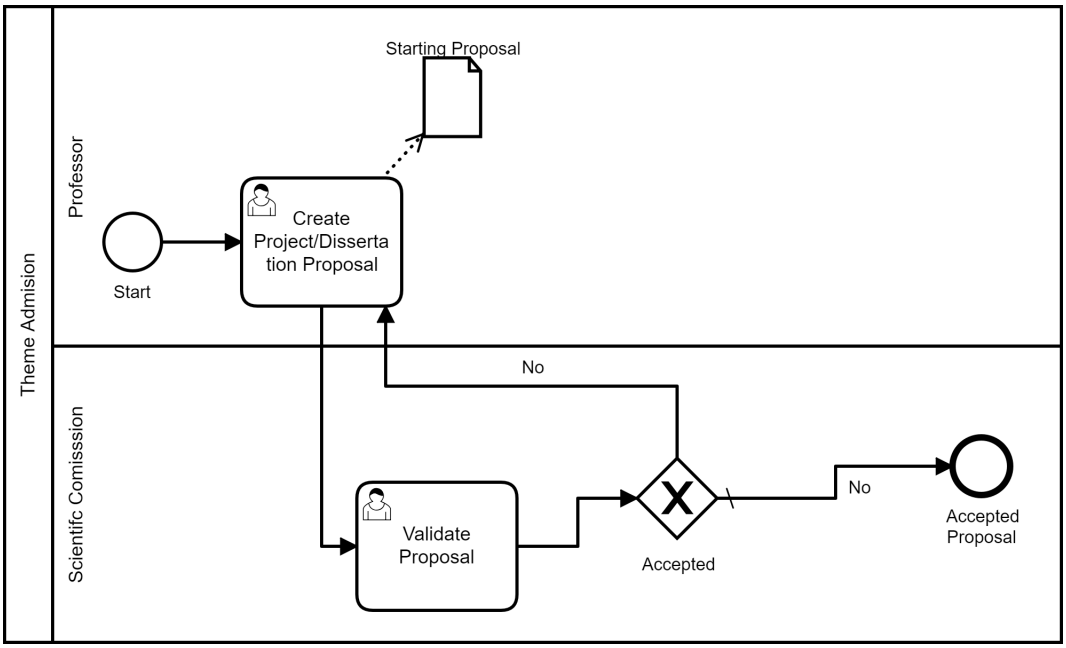

Figure 4.1: Admission of Proposals Model

The model represents whole process, since the creation a of proposal, it made by the professor, after going to evaluation, made by the scientific commission, and after going to be submitted to the IPB online platform.

Only professor and scientific commission participates in this process.

Divulgation of Proposals

Divulgation of Proposals process (figure 4.2), is the process where the scientific commission, after accept a proposal, starts the divulgation of it, in this way, a student can be easily found to start the development of a project. This process starts when a proposal is accepted and ends if the proposal starts to be developed or if the scientific commission reevaluate the proposal and decide to close it.

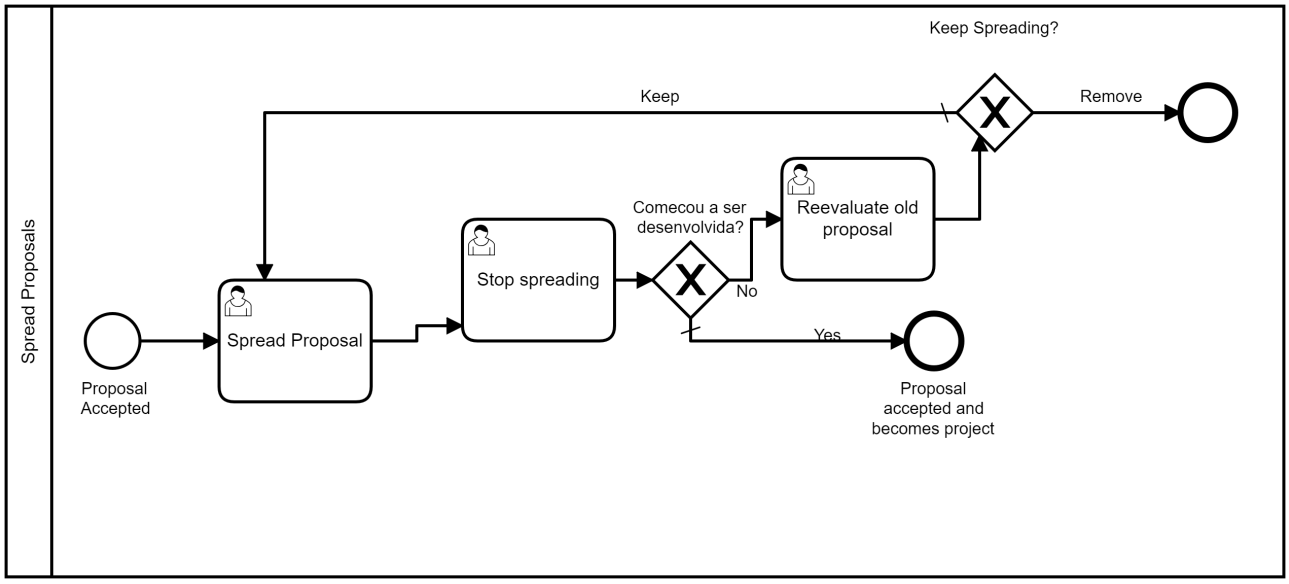

Figure 4.2: Divulgation of Proposals Model

The model represents the stage when the proposals are in divulgation, and in this process only the scientific commission participate.

Select the Student for Project

Select the Student for Project process (figure 4.3), is the process where the the professor, after defines a student to develop the project, The professor should write a project with the supervisors and the student and send it to the commission, the commission, in his part, should evaluate the project proposal and accept it or ask for a reformulation. This process starts when a proposal is assigned to a student and ends if the commission accept the project to be developed.

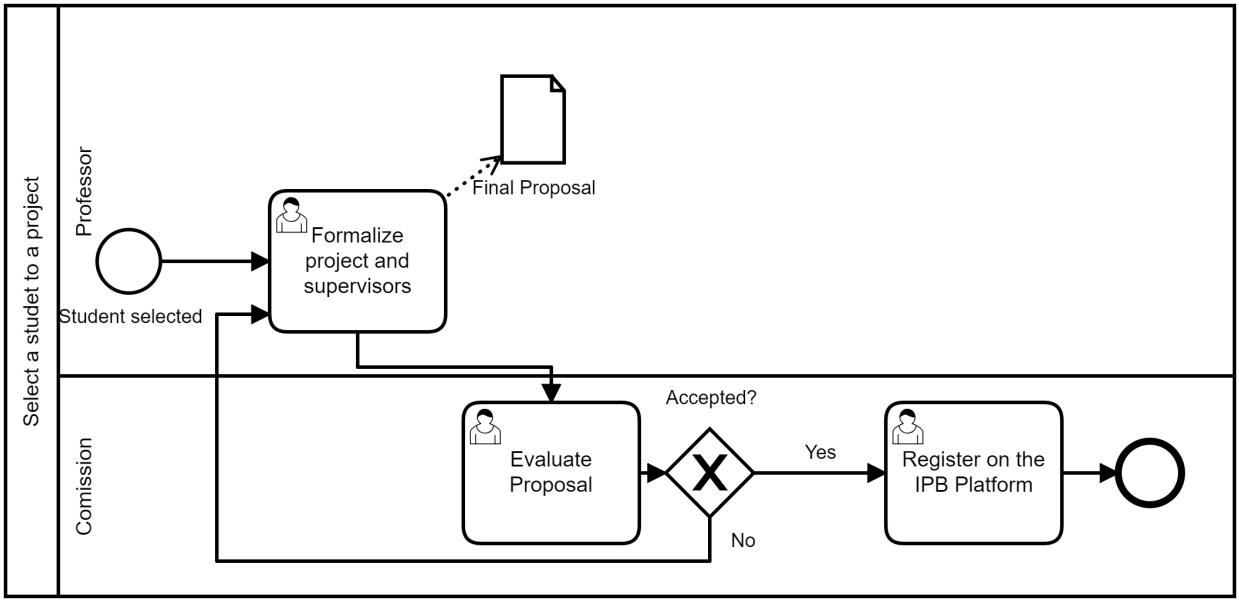

Figure 4.3: Select the Student for Project Model

In this process the professor should assign a student to develop a project (still being a proposal until starts development) and send to the scientific commission a project proposal, in turns the scientific commission should evaluate the project proposal and accept it or not, if it is accepted, commission should register the project in the IPB online platform

Select Board and Schedule Public Discussion

Select Board and Schedule Public Discussion of the final work (figure 4.4), is where an evaluating board to judge the methods and results obtained of a final work is selected, in this part some steps are necessary, such as the definition of the board members, the place and date of the public discussions and a previous evaluation of the project.

This process is related to the final part of the final project development and in this stage, the scientific commission should select the members to compose the judging board of the public discussion of a project, after the members of the board should evaluate the project and accept it or ask the student to reformulate the project, if the project is accepted the public discussion should be scheduled.

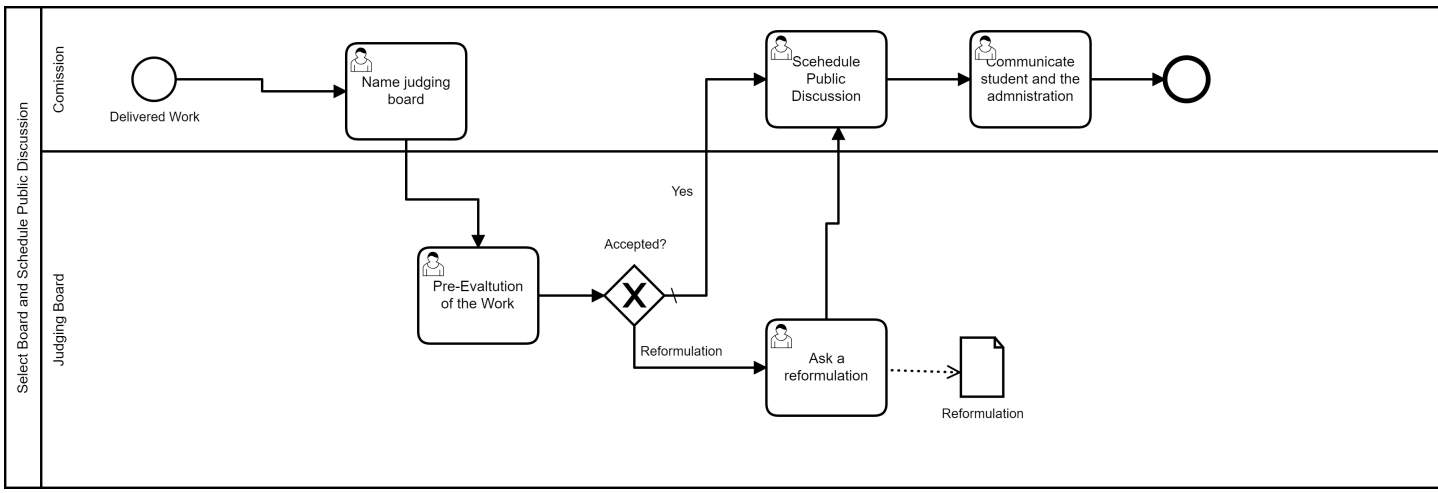

Figure 4.4: Select Board and Schedule Public Exam Model

4.2.4 Use cases Diagram

Use cases represent the requirements raised in the section in addition to the processes, and in order to differentiate between the types of requirements (normal and process), they are made with different colors, where the requirements for processes are painted green and the other requirements painted yellow as shown in the Figure 4.6 and Figure 4.5.

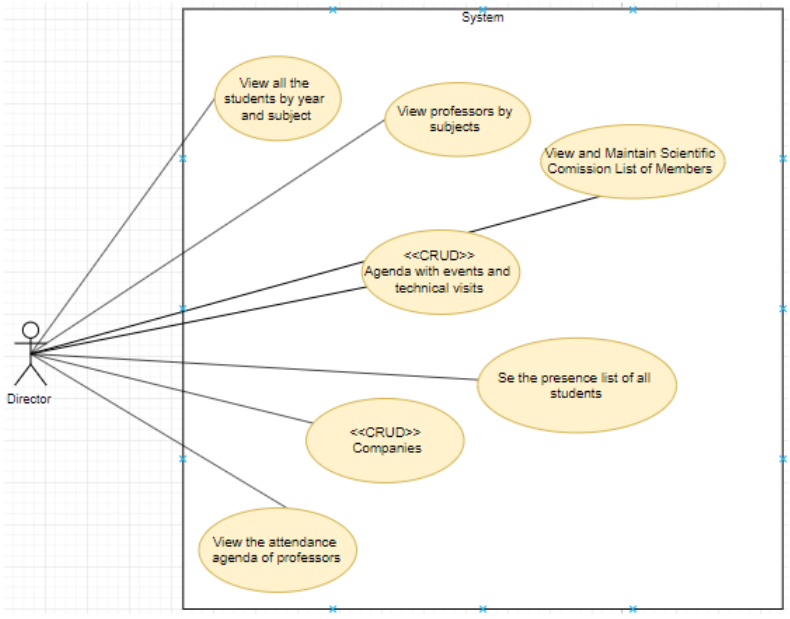

Figure 4.5: Use Cases Diagram

In this diagram we can identify four different roles: Professor, Board of Judge (Juri), Scientific commission (Comissão) and Director, and each of these roles represent different function inside the application.

The main role of the project is the Director and this role has the permission to access most of the software.

The secondary role is the professor, and the professor can manage the proposals and projects and just that.

After, we have the scientific commission, and the functions related to this role are evaluate proposals and projects, select members to be part of a judging board, schedule public discussions and do the divulgation of the proposals.

The last role, and the one with fewer functions, is member of a judging board, and the only function in the software is evaluate projects.

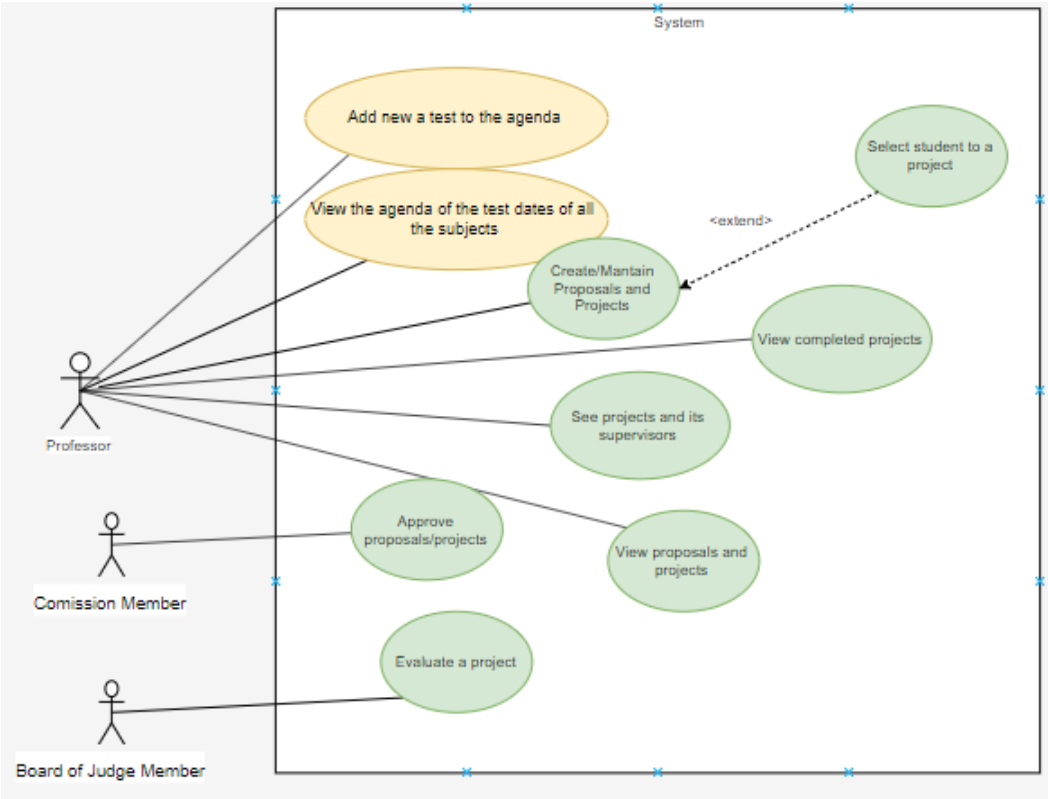

Figure 4.6: Use Cases - Business Process

4.2.5 Software Architecture

The software architecture helps to describe the operation of the structures and tools involved, making it easier to understand the flow of activity between application layers. The architecture shown in figure 4.7 represents the entire project.

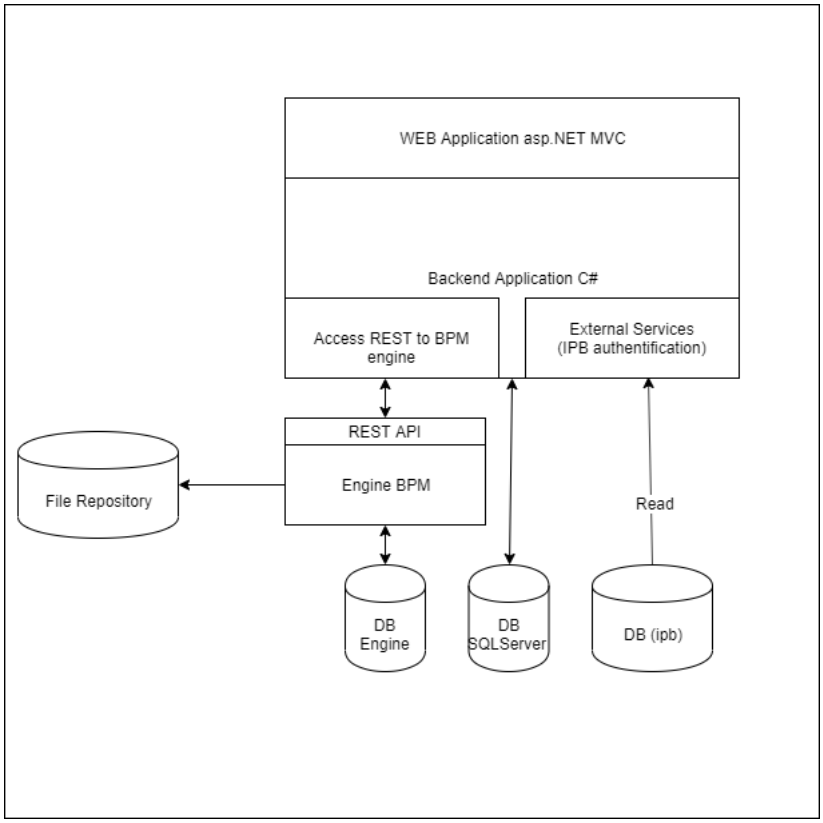

Figure 4.7: Software Architecture

To be more explanatory the project is divided into some parts that can be dealt with independently. Starting from the bottom we have access to external business process management tool (Camunda), this tool has its own implementation and database, and has implemented a REST API through which the main software communicates with the manager. In addition, the system has an interface with a database that was created during project development and is intended to support the maintenance of processes by the software. The last link with banks made by the software is with a bank that was created to simulate the IPB bases (databases containing data on authenticity, subjects,

professors, attendance). The highest part of the architecture shows that the back-end is done in C# asp.NET using the Model View Controller (MVC) pattern for development.

In this section, the databases and models are explained to be easier to understand about the way of working of the system.

Databases

The system, as it is for the use of different professors, must support login, and for this to be possible, the IPB contains the databases that are currently used in the institution's applications (online.ipb and virtual.ipb).

We did not have access to these databases during the development of the project, so the best way to overcome this obstacle was to create a database containing the data that in order to the IPB databases.

The idea of this database is to make all this information be concentrated on one side of the application, so if at any time the access to the databases is guaranteed, the process for integrating the application with the IPB databases is easier.

Software Models

In this topic, the data models used in application development are displayed. It is worth mentioning that the models were obtained by directly mapping the bases created using Visual Studio EntityFramework (EF) to do this.

The first model generated was the one related to the authentication part and containing the data that simulates the IPB databases. This model (Figure 4.8) contains only the data necessary for the implementation of the desired views, and when access to the bases is granted, the model can be maintained if the granted bank views have the same design.

With this model all the part of the login and identification of the user can be made, but just with these classes, we can't determine all the roles of the user, this part is in the other part of the models. Most of the data here is only for the features related to the director.

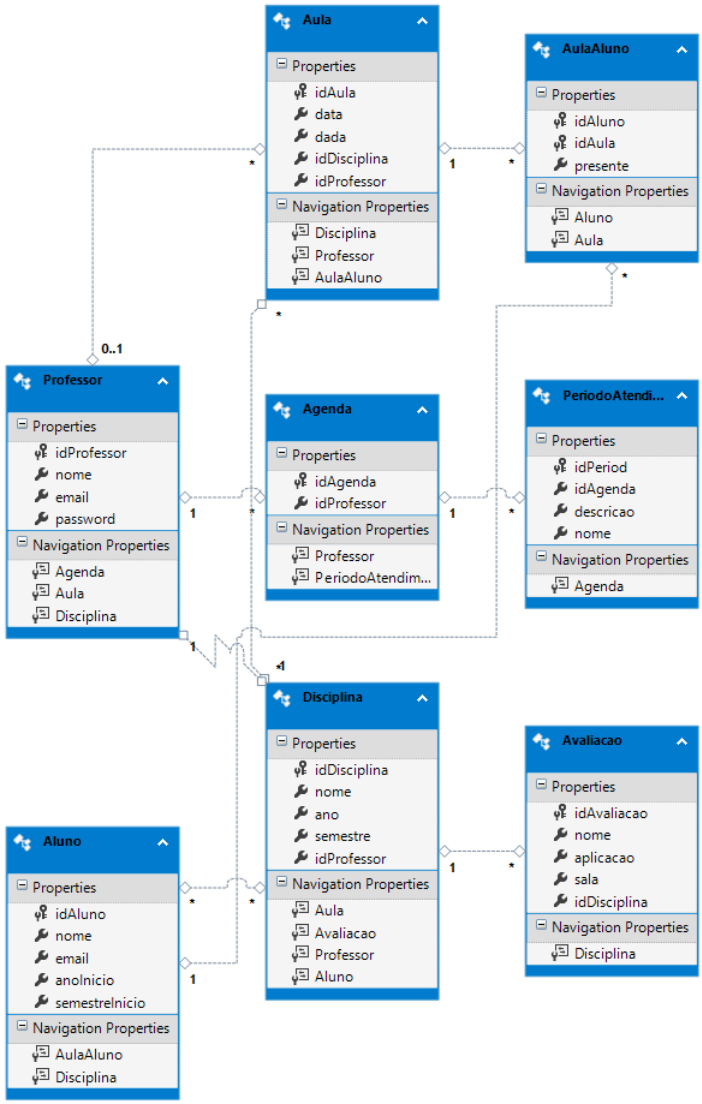

Figure 4.8: Model to simulate the access to the IPB databases - Generated automatically using Entity Framework

The second model is the one that was generated to support the execution of the processes, not the execution and maintenance like Camunda, but the structural part of the connection between professors, projects, proposals and the functions performed (scientific commission, judging board). This model (Figure in the appendix A.2) was also generated using visual studio EF. The classes shown in it represent the structure as obtained from the business process models, and contain fields (bpmid) to aid integration with ENGINE BPM.

This models was the basis to all the implementation of the project, the working of it is in the next sections.

4.2.6 Installation of the environment

With all models (data and process) created, the next step was to create a development environment as well as a working environment, where the BPM engine was running and processes already deployed, so the process environment would be ready to be integrated into the application.

The engine chosen was Camunda and for its use some necessary requirements must be met, in addition to the fact that the modeler camunda and the engine are distributed in different applications.

Camunda Modeler

Installation of the Camunda modeler is optional due to the fact that processes can be deployed to the engine via API rest, but for ease in the design and mapping of models, it was chosen to install and use the Camunda Modeler since it also has this function of deployment on it.

Installation requirements for camunda modeler are basic, only Java Runtime Environment 1.7+ is required, and can be downloaded directly from the camunda website.

Installation is quick and you just have to press next. When the installation is complete Camunda Modeler can be run, and it looks like the figure 3.11.

The modeler have all the things needed to create a BPMN model, and, also have button to deploy a process to the engine, which is marked in yellow in the Figure 4.9.

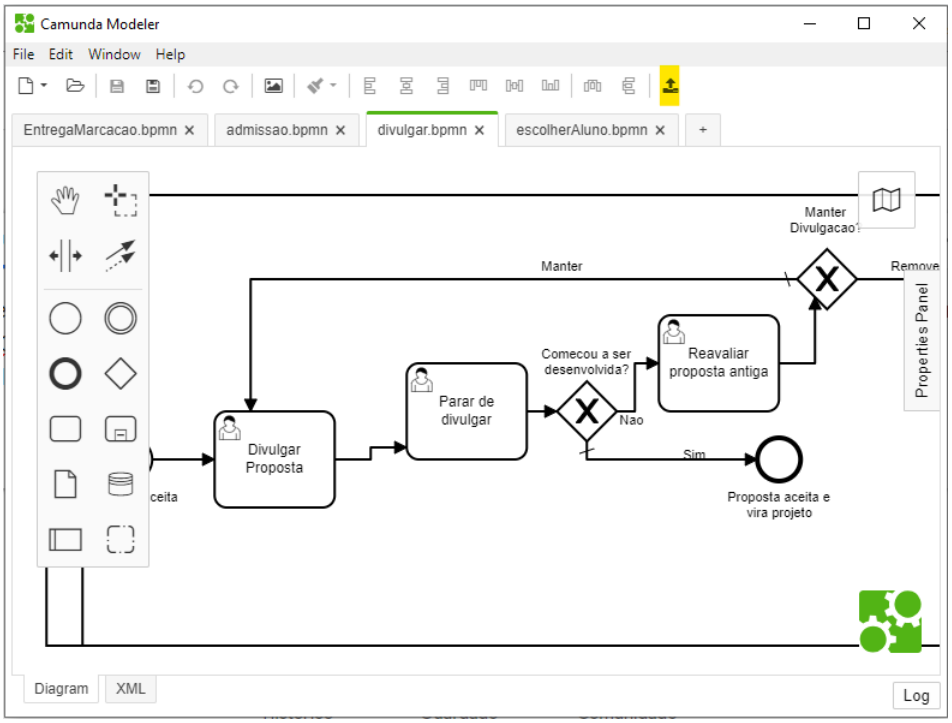

Figure 4.9: Camunda Modeler deployment button

This button will not work if the engine is not running, because the model have to be deployed to a Engine, so, to that the Camunda Engine BPM should be installed and be running. The installation and the models deployment are described in the next topic.

Camunda - Engine BPM

The execution of the process is divided into two stages, the first one is the stage in which the models are created, and this stage can be completed only using the Camunda Modeler, but the second stage is a bit different, because to the processes be executed it's necessary the installation of the engine.

Camunda BPM is a Java-based framework. Camunda BPM also provides a REST API which allows you to build applications connecting to a remote process engine. The version used in this project is the Open Source Community Platform, which is licensed

under the Apache License. It can be downloaded from the Camunda website.

The engine installation have some requirements like JRE (Java Runtime Environment), or a JDK (Java Development Kit) installed.

With all the requirements done, to install you will download a .ZIP file and extract the files to a folder. In this files you will see a file named start-camunda.bat, and this file will put the engine to run.

The Camunda BPM is under Apache license due to the fact that the application HTTP server is Apache Tomcat compatible with the version 7+.

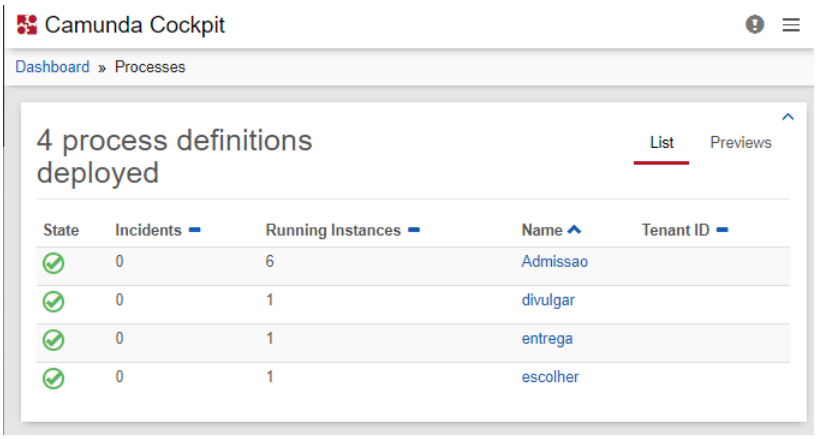

Figure 4.10: Camunda Processes

After start the engine, the website is running in the LOCALHOST at the port 8080, and the first page to see is the login page (credentials "demo" and "demo" as login and password respectively) and after login, the administration pages of the Camunda BPM is shown (Figure 4.11).

After that, to be able to develop the software the next step is deploy the models to the Camunda BPM and it can be made using the Deployment button described earlier. When you press the button the interface to deploy the process (Figure 4.12) just ask the target server, the name and if some authentication is needed. If the model is correct, the deployment will be done, if it's not, a log is generated and you can fix your model.

At the same time, you can start to create the groups (figure 4.13) in Camunda BPM to separate the functions of the processes in the BPM.

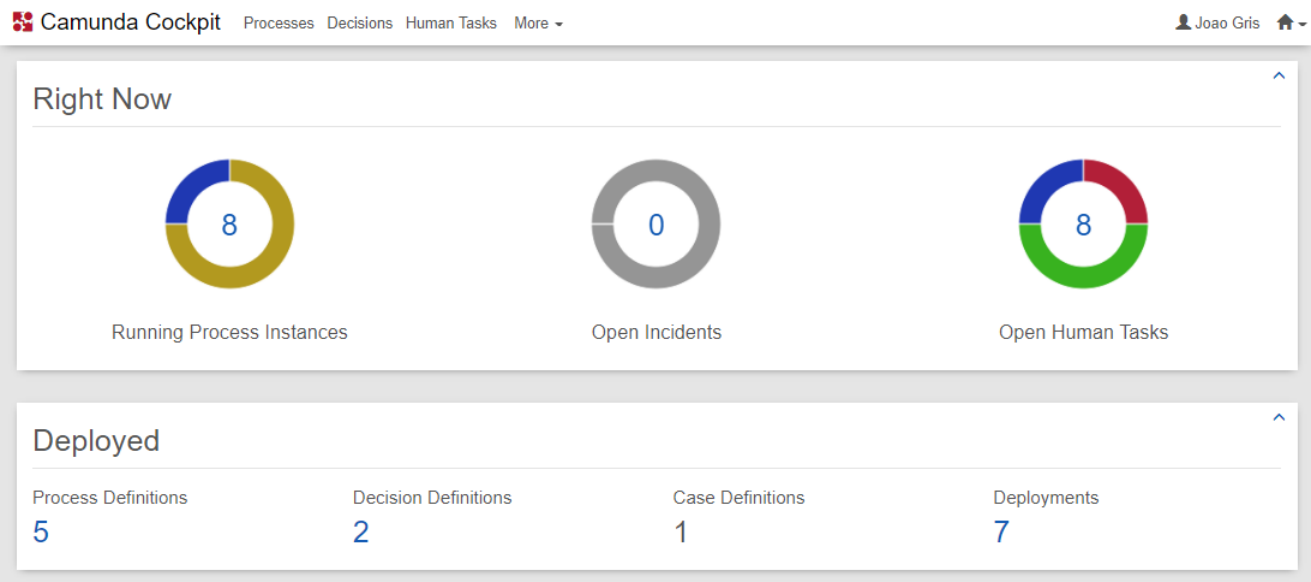

Figure 4.11: Camunda Processes Cockpit

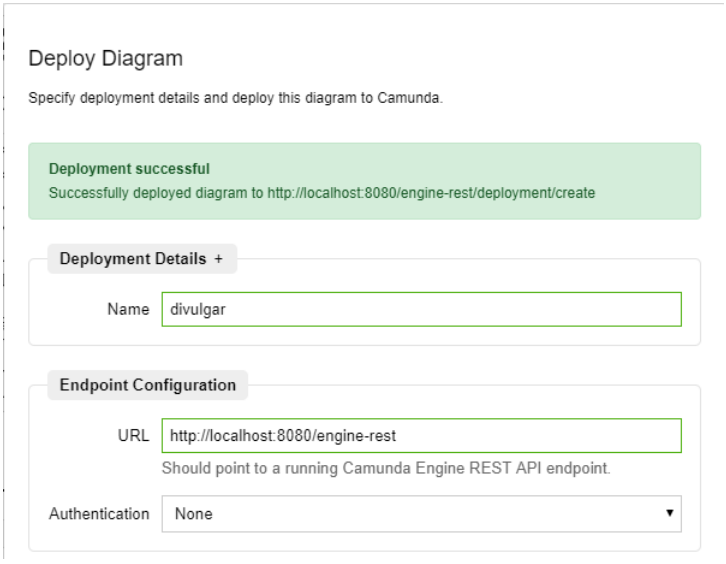

Figure 4.12: Camunda Modeler Deployment

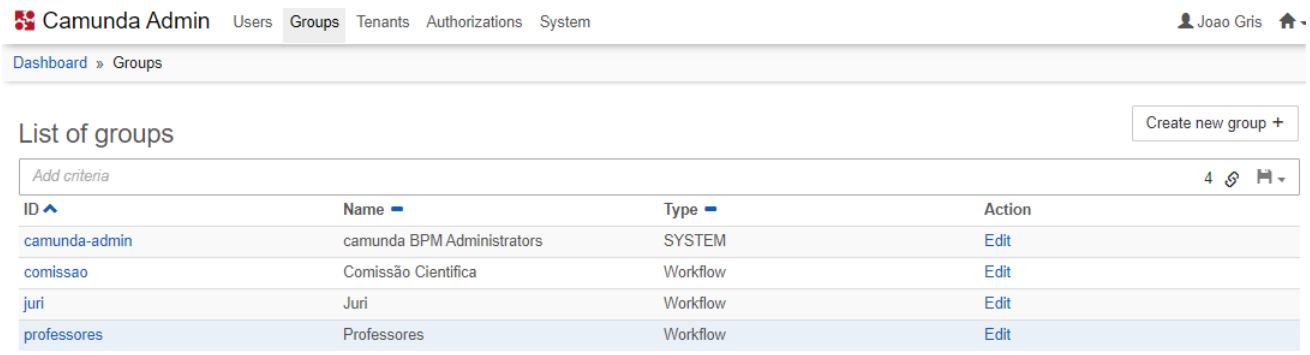

Figure 4.13: Camunda BPM - Groups

The Camunda BPM does all the process maintenance work and it is through it that the application gets the process information. To make this possible, BPM implements a REST API service where the entire process of executing a process instance can be done through it.

As can be seen in figure 4.14, the POST request made through an external application where a process instance is created and returned to the creator, the identifier of this process instance, so that the instance identification and subsequent procedure can occur in a controlled manner.

Many other methods are implemented and allow the user to complete tasks of processes, retrieve the status of the processes, retrieve information sent to processes previously, complete tasks choosing the path of the model to be followed sending the decisions through JavaScript Object Notation (JSON) within the calls to the Camunda BPM.

After deploy all the models, the structure in the side of processes are done and now the development of the software can starts.

4.3 Implementation

With all the environment ready and the processes already deployed, the next step is the software implementation. For this the technology was chosen to meet the needs of the application and also for the previous knowledge about its use. Because of this C# was

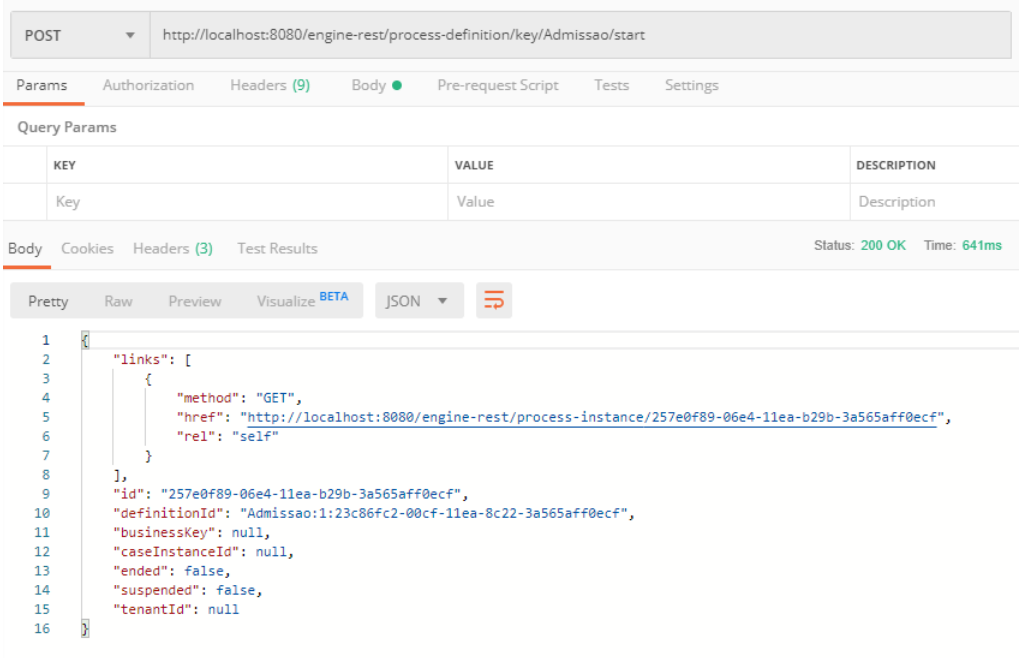

Figure 4.14: Starting a process from an external Service in camunda

chosen and for that, and used ASP.NET with MVC pattern in the project. In addition, for databases the chosen database server was SQLSERVER 2017.

This section contains the structure of the project, organization of the files in the project, and some examples of implementation made in the software. The idea is show how it was made, and after, in the next topic, all the features of the system will be explained.

The organization of the files in the project follow the patterns of the MVC and how you can see in the figure 4.15, in this part of the structure we can see the controllers divided into two groups, one is for the data that comes from the database that is the simulation, and so are separated.

The logic behind the implementation is very simple, first the object models were obtained through the data models, and for this we used the EF, which generates the model and manages the bank connection independently, making programming much easier and the models obtained are described previously in this chapter.

With the models, we can start to create the views of the system, and the first view

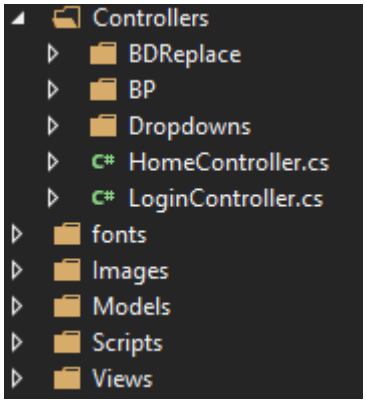

Figure 4.15: Software Project Structure

done was the Login view (figure 4.16). The logic behind the login view is easy, the input data is passed from the view to the controller and the controller makes a POST call to send the user and password to be validated, if it is valid, login happen and you are redirected to the homepage, if its not, you remain in the same page.

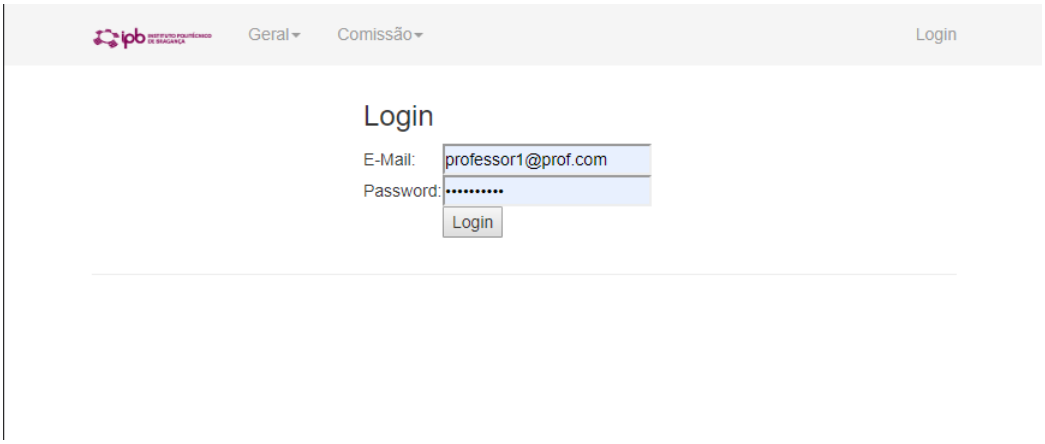

Figure 4.16: Login Page

The logic is the follow: There are in the view some buttons with actions, when a button is pressed in the view, an action correspondent to this button is activated, this action is implemented in the controller, and the controller access the model to validate operations that happens in the views. The model in turns, is sync with the database, in this way, all the software works together to make it happen right.

The code to login is shown following in the Figure 4.17:

```
[HttpPost]
public ActionResult Login(string email, string password)
{
var query = from st in dbr.Professor
            where st.email == email && st.password ==password
            select st;

Professor professor = query.FirstOrDefault<Professor>();
ProfessorBP professorbp = dbbp.ProfessorBP.Where(s => s.idAutenticacao == professor.idProfessor)
          .FirstOrDefault<ProfessorBP>();
if (professor != null)
    {
    Session["professor"] = professor;
    Session["professorNome"] = professor.nome;
    Session["professorBP"] = professorbp;
    if(professorbp.Diretor.Count>0) Session["diretor"] = 0;
    if(professorbp.ProfessorJuri.Count>0) Session["juri"] = 0;
    if(professorbp.ComissaoProfessor.Count>0) Session["comissao"] = 0;


    return RedirectToAction("Index","Home");
    }
    else
    {
        ViewBag.error = "Invalid Account";
        return View("Index");
    }
}
```

Figure 4.17: Login Code

In this code, first the credentials are tested and after if the credentials are right, the data of professor is saved in the session and redirect to the first page, if its not, just return an error.

Other kind of implementation made in the software was the part related to link the application with the Camunda BPM, and do that is very simple, one example of that is the way to start a process (just a POST call Figura 4.14). In the code make the calls is in the same way, you have to create an http client, set the URL and after that make the call. The result of the call, if is right, is a json with the informations about the created process, and the id of the process is atacched to the model.

Many tasks of a process can need some parameters, it is the case of decisions in the models, and to create this kind of calls, the only difference is that you have to create a body to the request and send the parameters to the engine (Figure 4.18).

In addition to these structural facts, the control of access to functions is also done by the application, and this can be seen in the login function (Figure 4.17), where, already in the session, the functions of the logged in user are stored, thus, the functions Director, Member of The judging board and member of the scientific committee may not appear.

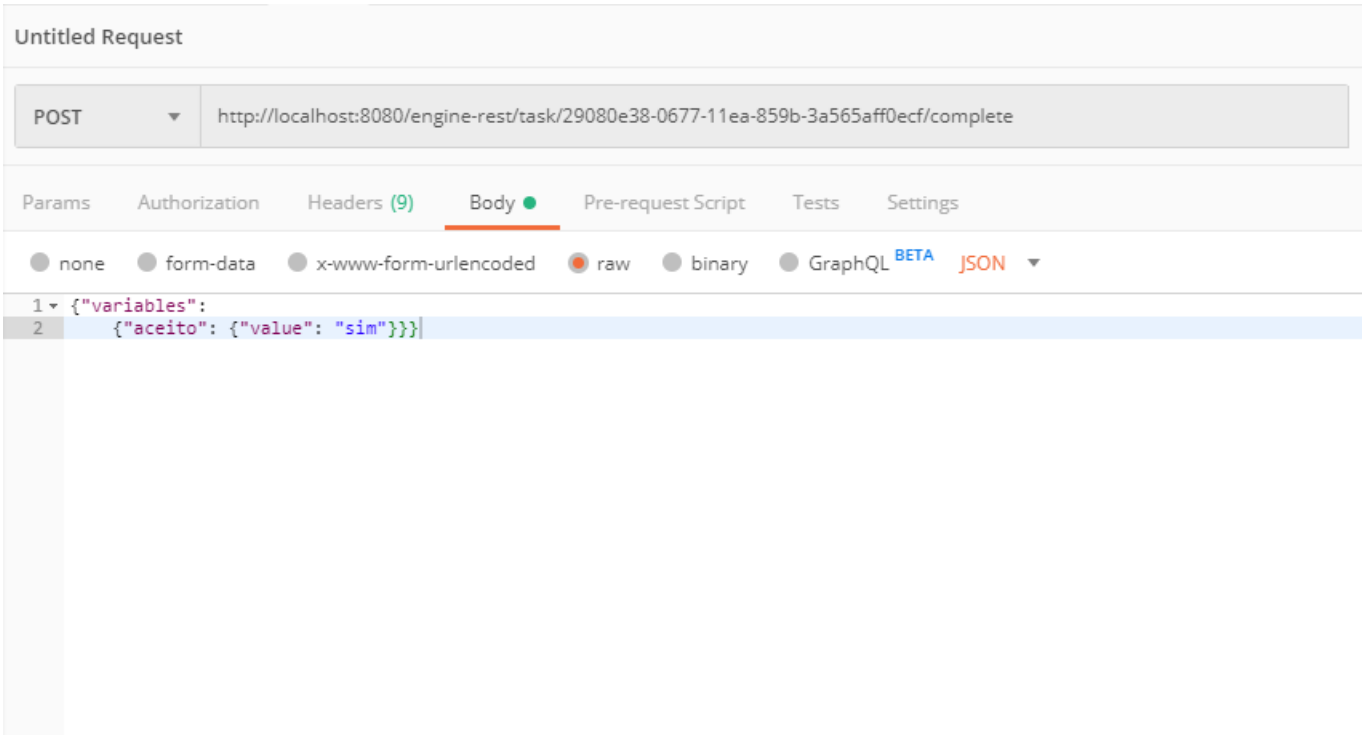

Figure 4.18: Call to complete a decision in a process

All of other views and controllers were implemented using the same logic, just changing models and some verifications.

In this way the next step is show all the features of the system and describe them a little.

4.4 Features

The software without the user loses some sense, because it is with him that you can know the functions and ensure access to them, so without logging in, the user can only see lists of proposals, projects, and public discussions scheduled, you can see also who are the members of the scientific commission (Figure 4.19). The other views of the system are in the Appendix C.

Nothing can be done beyond that without first logging into the application.

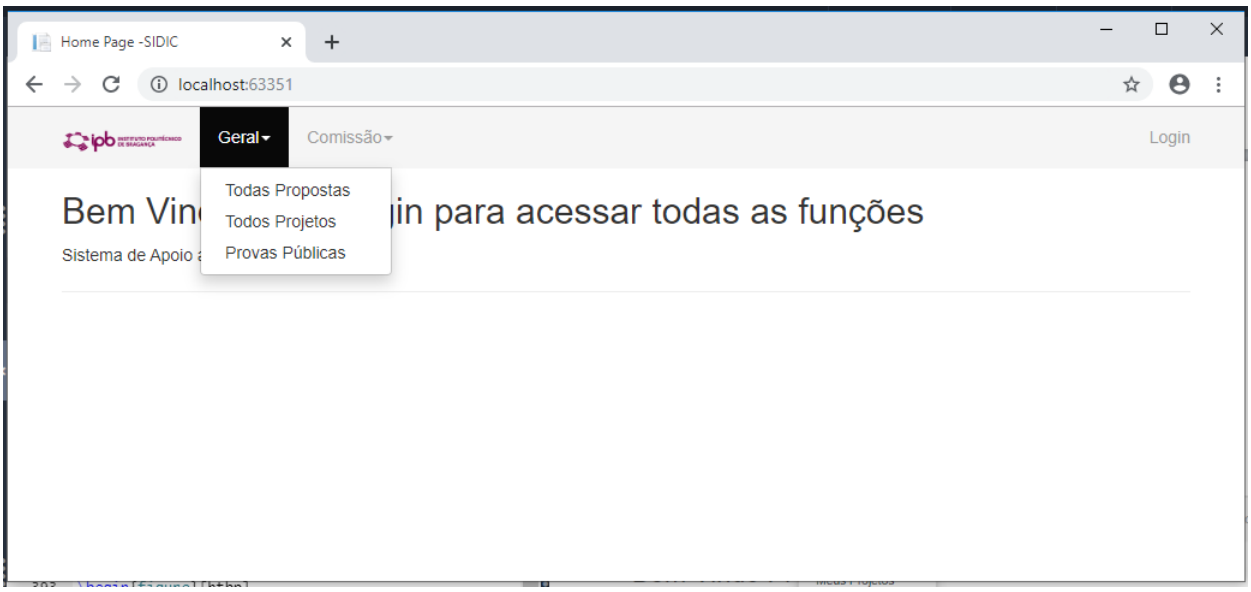

Figure 4.19: Features without login

4.4.1 Features related to director

When logged in, if the user is the director of the course, he should be able to see this dropdown menu, where all the functions related only to the director are (figure 4.20).

The functions are based in the Use case Diagram (figure 4.6) and are described below the operation of these features.

- Alunos (Students)

  In this feature, director can see all the students of the course and he is able to see all the personal information and information about the subjects and frequency of the students.

- Professores (Professors)

  In this feature, director can see all the professors of the course and he is able to see all the personal information and information about the subjects given by this professor.

- Acompanhamento das Disciplinas (Monitoring of Subjects)

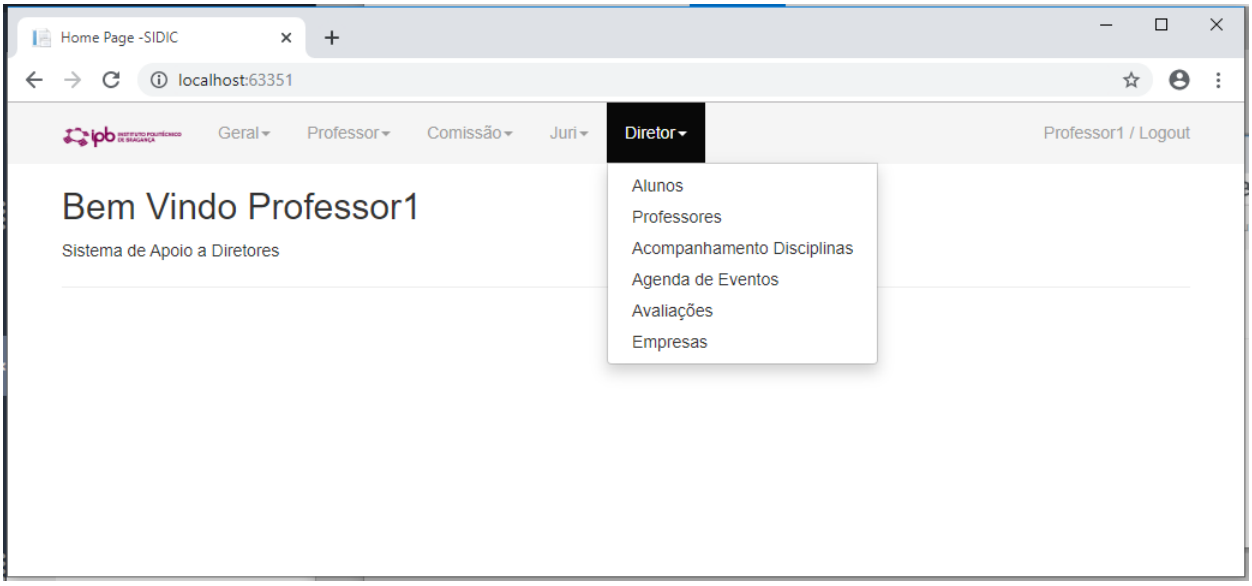

Figure 4.20: Features related to director

In this feature, director can see all the subjects of the course and he is able to see all the detailed information and information about the subjects, like frequency, tests of it, classes given, responsible professor.

- Agenda de Eventos (Events Agenda)

  In this feature, director can manage the Events Agenda, where all the events of the semester should be recorded, in addition to the Study visits. Director can create, view, update and delete all the events.

- Avaliações (Tests)

  In this feature, director can see all the test points in the semester of all the subjects.

- Empresas (Companies)

  In this feature, director can manage the Companies list, where all the companies that are partners of the course or the institution are listed. Director can create, view, update and delete all the companies.

4.4.2 Features related to scientific commission

When logged in, if the user is a member of the scientific commission of the course, he should be able to see this dropdown menu, where all the functions related only to the the commission are (figure 4.21).

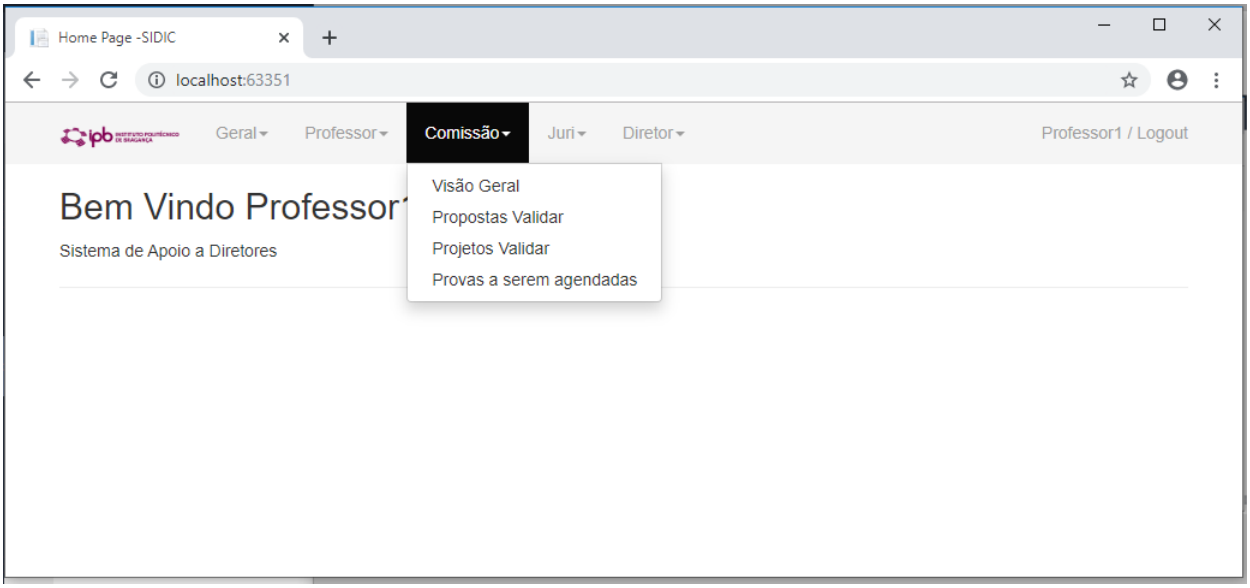

Figure 4.21: Features related to scientific commission

- Visão Geral (Overview)

  In this feature, all users can see who are the members of the Scientific commission.

- Propostas Validar (Proposals to be validated)

  In this feature, a member of the scientific commission can see all the proposals made by professors waiting to be evaluated, in this case, the member just can't evaluate his own proposals. This feature is related to the admission of proposals process

- Projetos Validar (Projects to be validated)

  In this feature, a member of the scientific commission can see all the proposals made by professors waiting to be evaluated, in this case, de member just cant evaluate his own proposals. This feature is related to the select student to a project process.

- Provas a serem agendadas (Public Discussions to be scheduled)

  In this feature, a member of the scientific commission can see all the projects, where the judging board already read the project and accpted it, and only the schedule of the public discussion is missing. This feature is related to the Select Board and Schedule Public Discussion process.

4.4.3 Features related to judging board

When logged in, if the user is a member of a judging board, he should be able to see this dropdown menu, where the only function related is (figure 4.22).

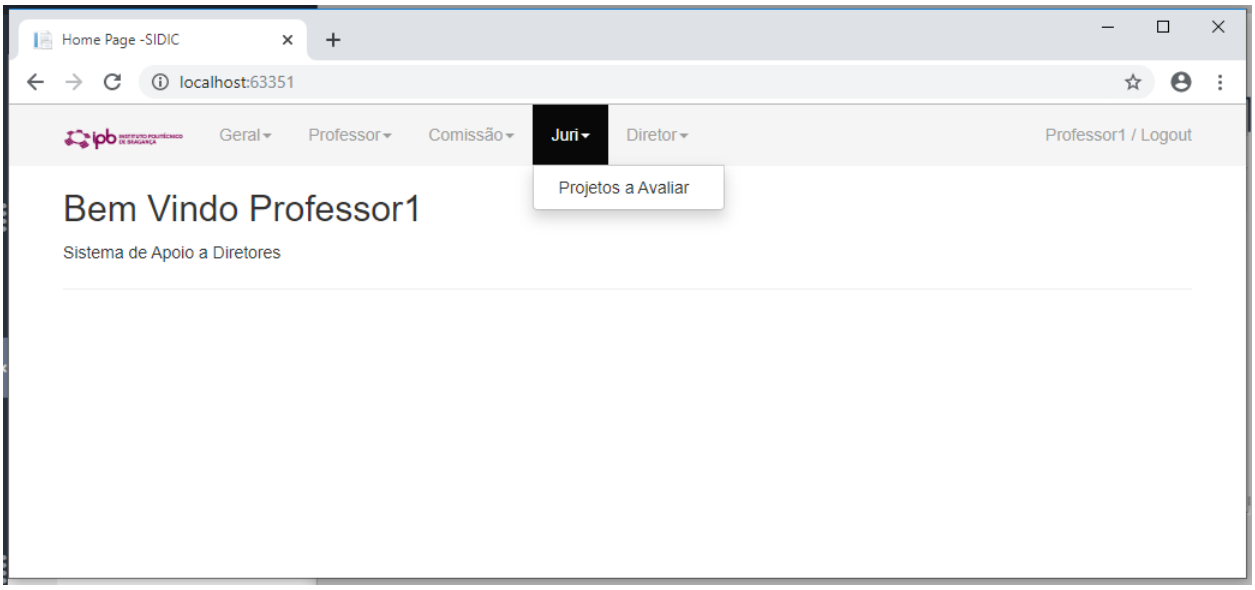

Figure 4.22: Features related to judging board

- Projetos a Avaliar (Projects to be evaluated)

  In this feature, a member of a judging board can see all the projects he have to read and evaluate.

  This feature is related to the Select Board and Schedule Public Discussion process.

4.4.4 Features related to professor

When logged in, if the user is a professor, he should be able to see this dropdown menu, where all the functions related only to the the professors (figure 4.23).

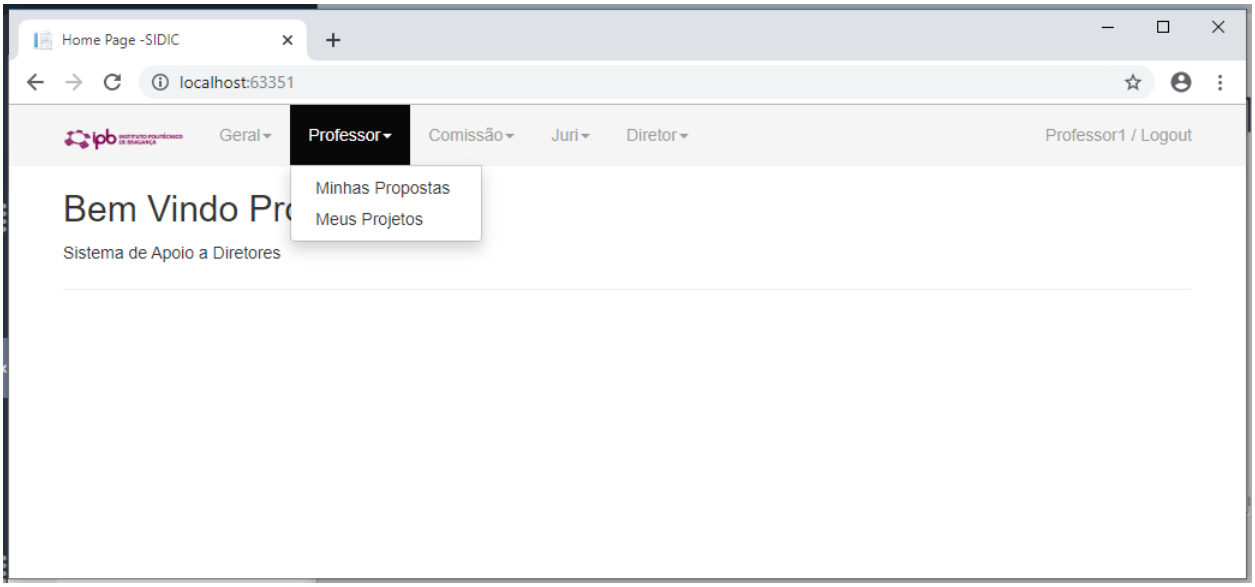

Figure 4.23: Features related to professor

- Minhas Propostas (My Proposals)

  In this feature, professor can manage his proposals. Professor can create, view, update and delete all the proposals, and is here where the professor can check the state of his proposals. In this part the Admission process is started, when a professor tries to create a new proposal.

- Meus Projetos (My Projects)

  In this feature, professor can manage his projects. Professor can create, view, update and delete all the projects, and is here where the professor can check the state of his projects. In this part the select of student process is started, when a professor tries to create a new project to be developed.

4.5 Conclusion

This is the end of the software project and it is also the end result of the project and the result obtained was satisfactory. As you can see many functions are implemented and most of the requirements have been covered.

This system was proposed to assist in the accomplishment of some tasks and it has the necessary requirements to fulfill this function and only the continuous use and evaluation of it can bring improvements to the next versions.

Chapter 5

Conclusion

At the end of this work, looking at what was produced we can see that, besides the software, a small body of knowledge was also created, being it about Business Processes and tools for its management.

The project aimed to meet the needs of the director, eventually growing a little more due to the other functions that can be performed during the processes, so the scope of the system opened a little more.

The final design was consistent and the final result was as expected, but not everything went this way, so some functions and adjustments are required for better system operation in the future.

The final system can support any operations and, in this way, be very helpful.

For this work some considerations have to be made, in order to show what were the problems that were raised and also to show where the system has possibility to grow.

Initially, the process management part was used only to maintain the sequence and state of each process instance, access control to each resource in the BPM is done by code and not by motor configuration, so safety in this regard got a little flawed.

Another thing that was not worked on is the quality of the visualizations, they were made to display data, but were not so well thought out to do it in a more pleasant way.

Another consideration that can be made but mentioned earlier is that if access to IPB databases were granted the program would be leaner and easier to develop as it would

only need to consume data on the system without need for data collection and database design.

Finally, some related work that may be done in the future are: fine-tuning BPM settings, modernizing and smoothing views.

Another thing that would be interesting to do would be the reengineering of processes over time, because the information gathered throughout the execution time, much more would be known about their operation and could be better portrayed.

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Appendix A

Database Models

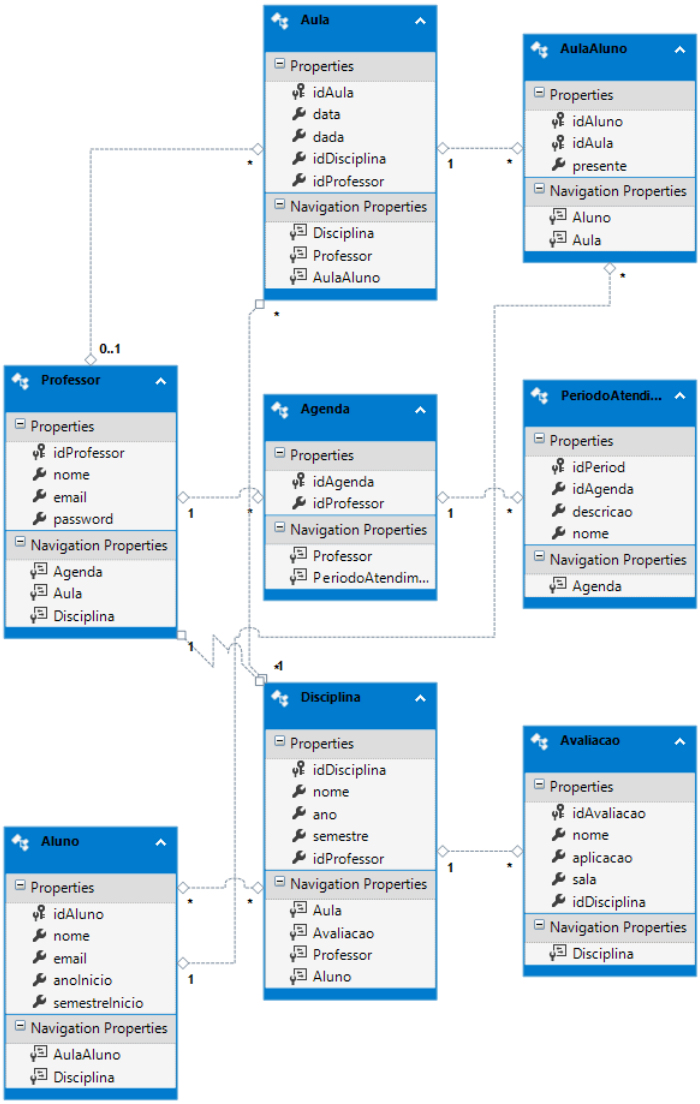

Figure A.1: Model to simulate the acces to the IPB databases - Generated automatically using Entity Framework

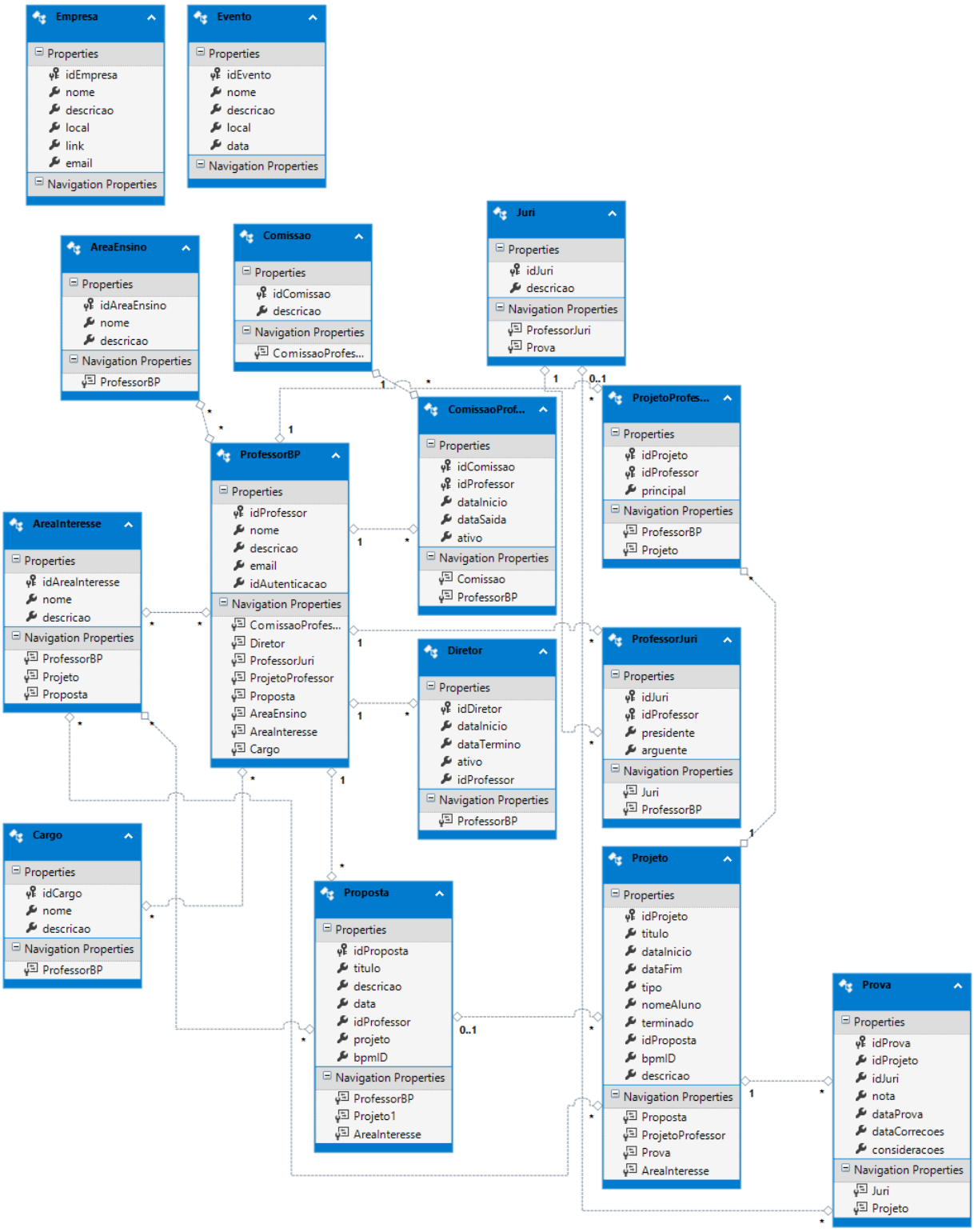

Figure A.2: Model to support the BPM Execution - Gerated automaticaly using Entity Framework

Appendix B

Survey Appendix

#	Kind	Version/Feature
1	Qual	Facility for process drawing
2	Qual	Possibility to attach informations to the activities (business rules, costs, systems, generated documents, etc.)
3	Qual	Integration with database and external systems
4	Qual	User Interface
5	Qual	User Experience
6	Qual	Process Simulation and Execution
7	Qual	Dynamic form editor for the human tasks
8	Qual	Support of the modeling guidelines
9	Quan	Use standard symbology notation
10	Quan	Possibility to collaborate in drawing
11	Quan	Compatible With Linux
12	Quan	Compatible With Windows
13	Quan	Compatible With WEB
14	Quan	Installation file size*
15	Quan	Group and user definition
16	Quan	Process version control

Figure B.1: Survey Features

Appendix C

System Views

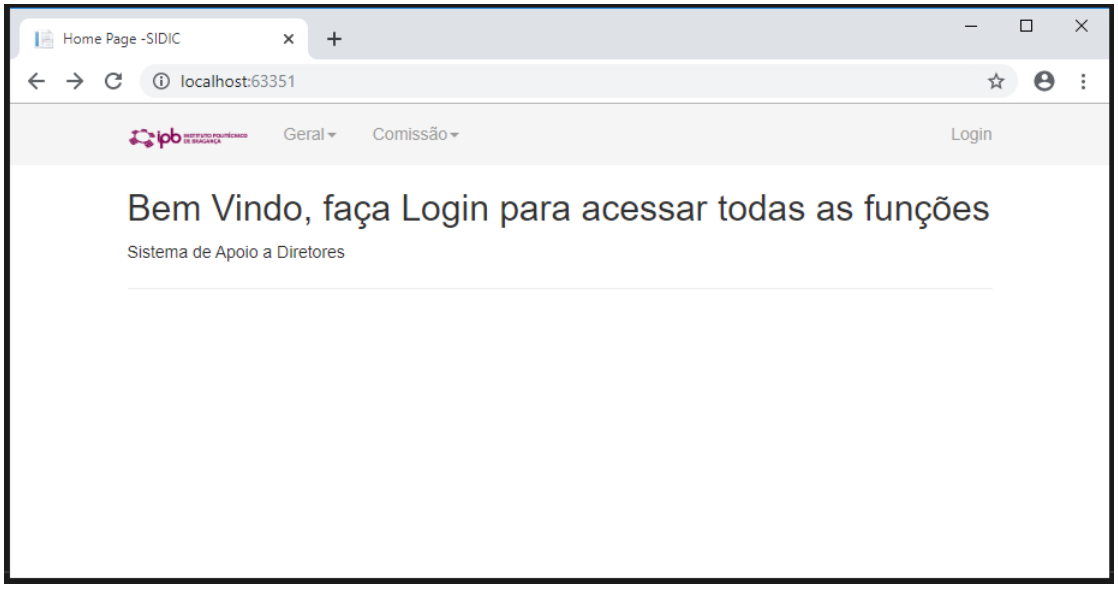

Figure C.1: Home Page

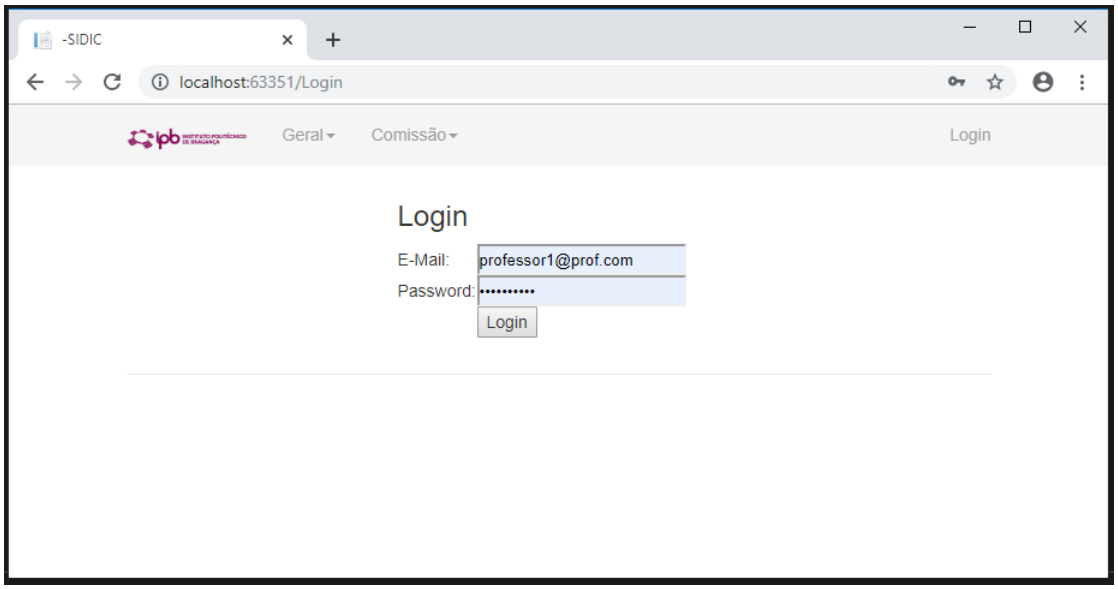

Figure C.2: Login Page

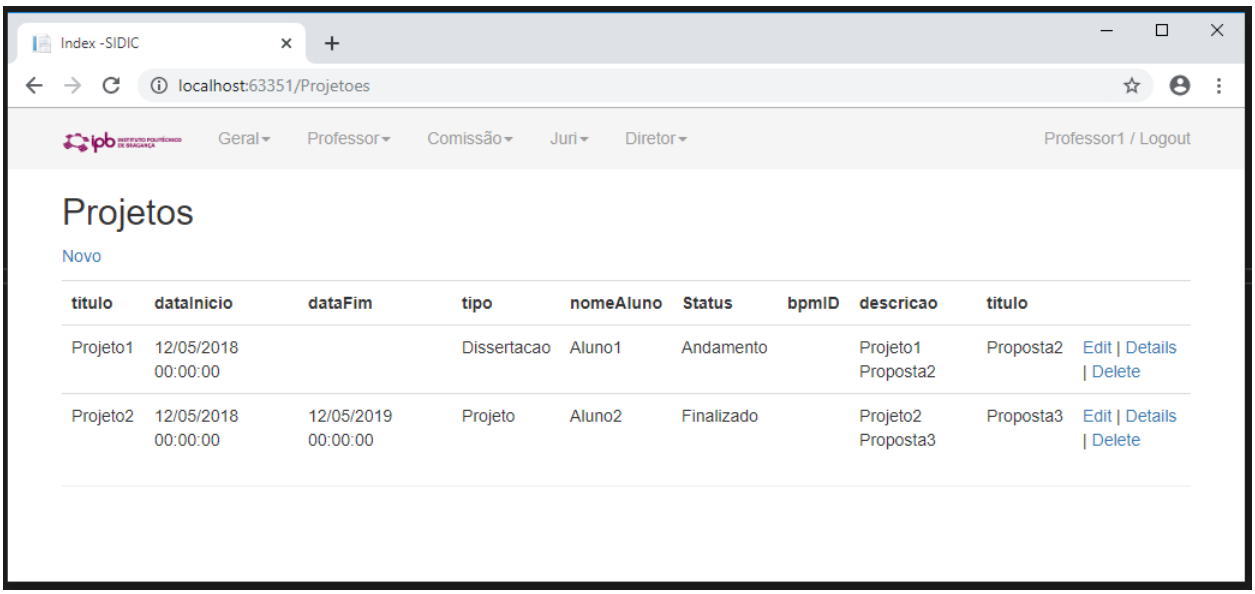

Figure C.3: General View Projects

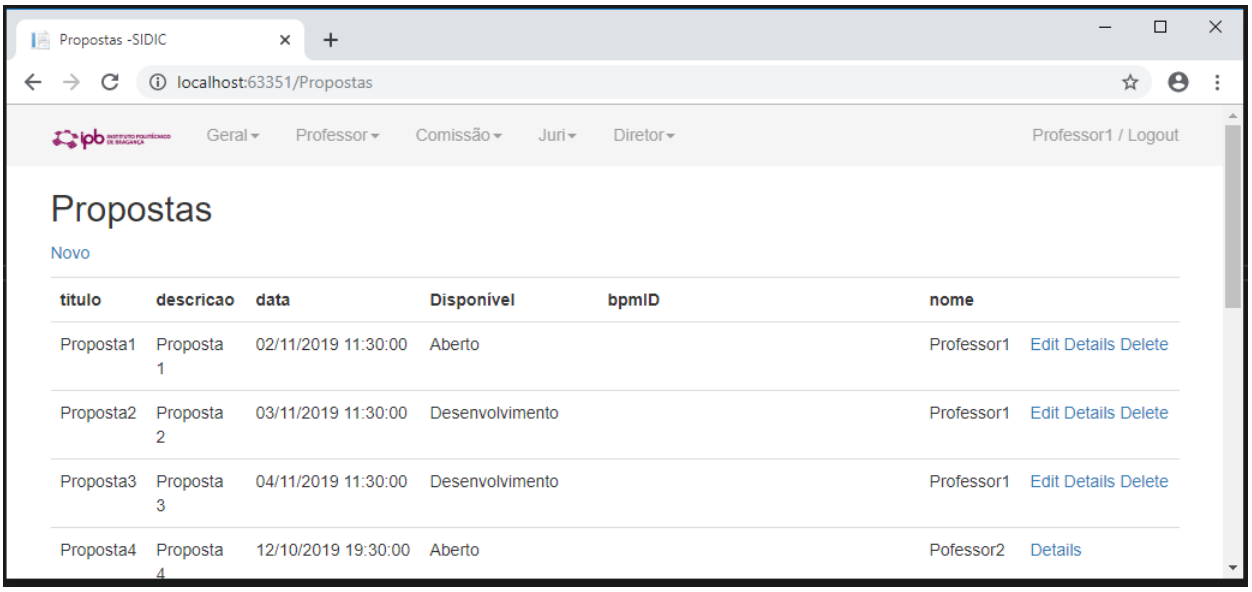

Figure C.4: General View Proposals

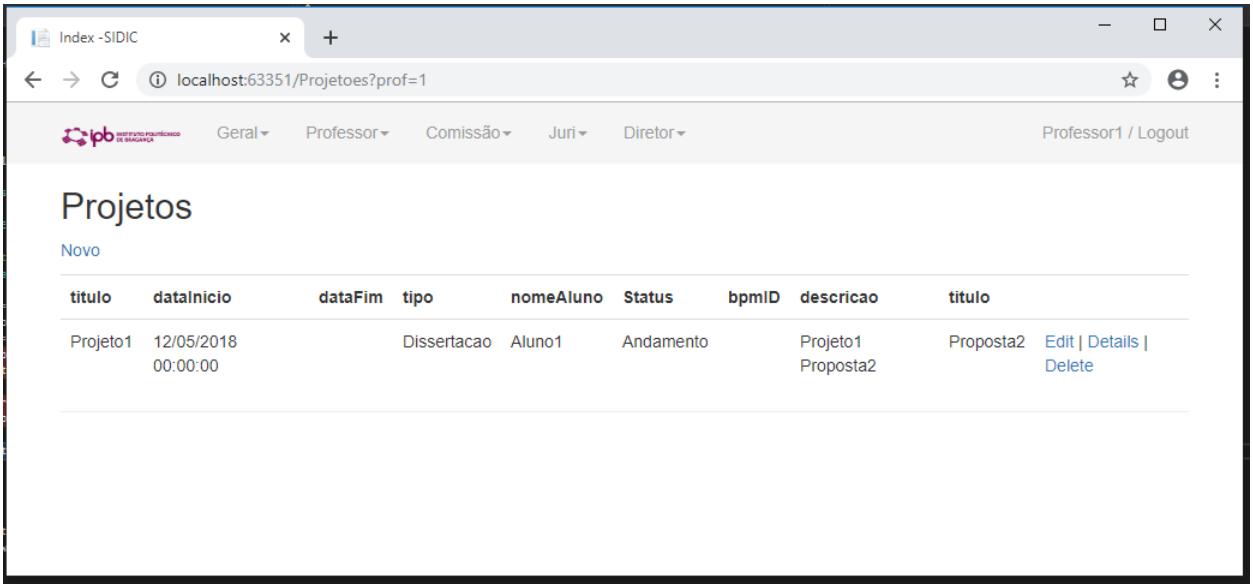

Figure C.5: Professor Projects Page

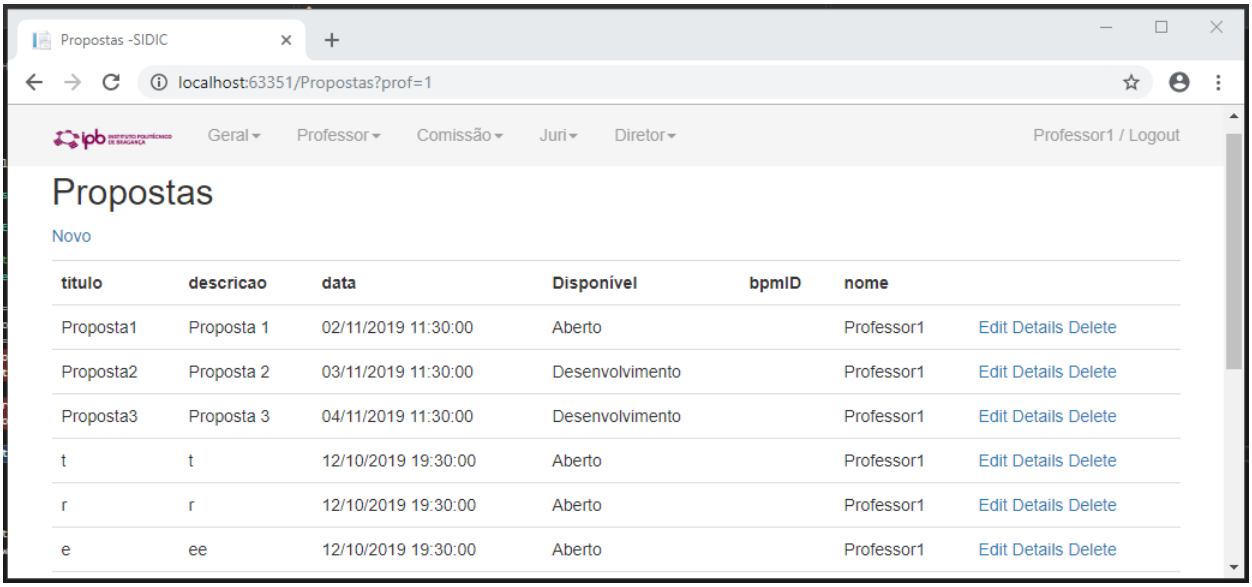

Figure C.6: Professor Proposals Page

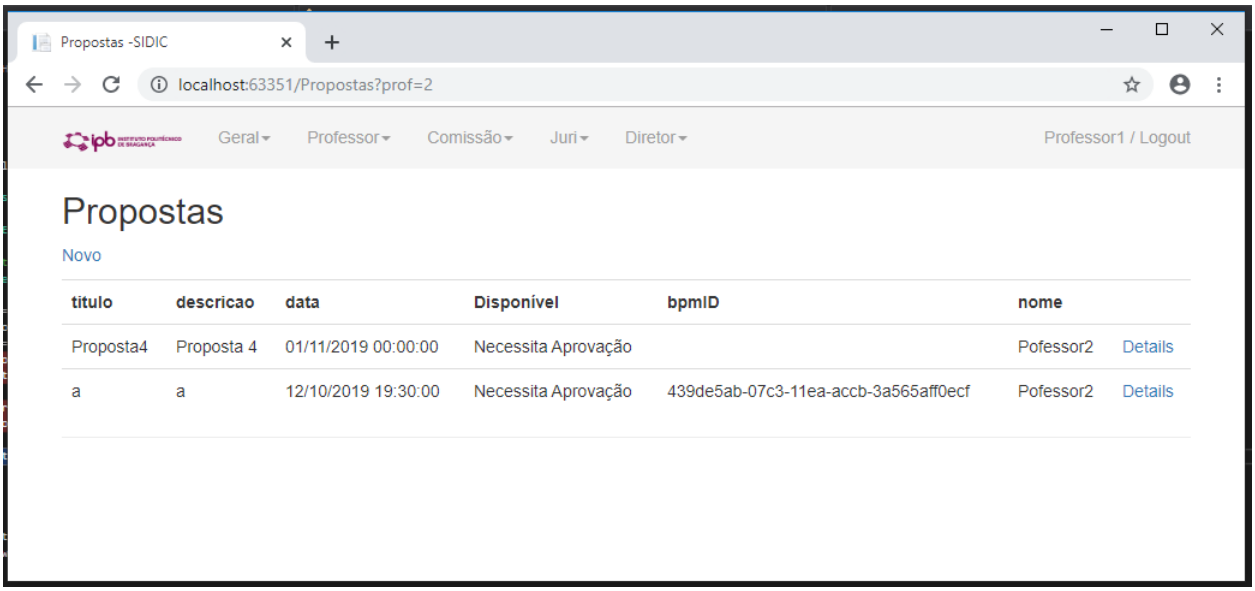

Figure C.7: Scientific Commission Proposals to be Approved

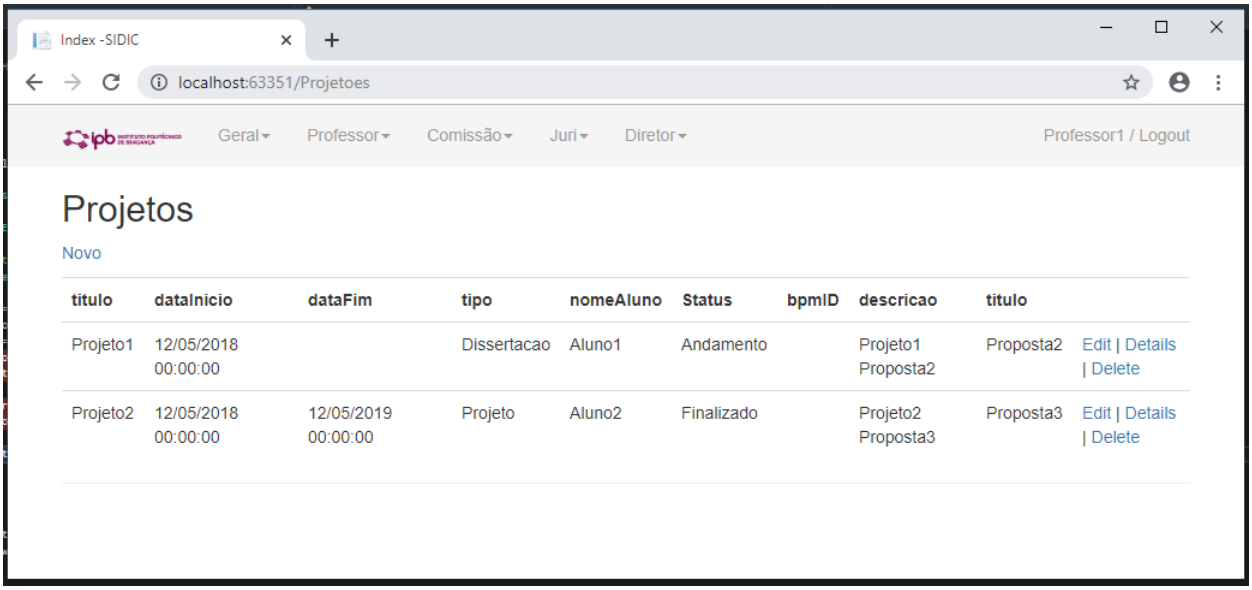

Figure C.8: Scientific Commission Projects to be Approved

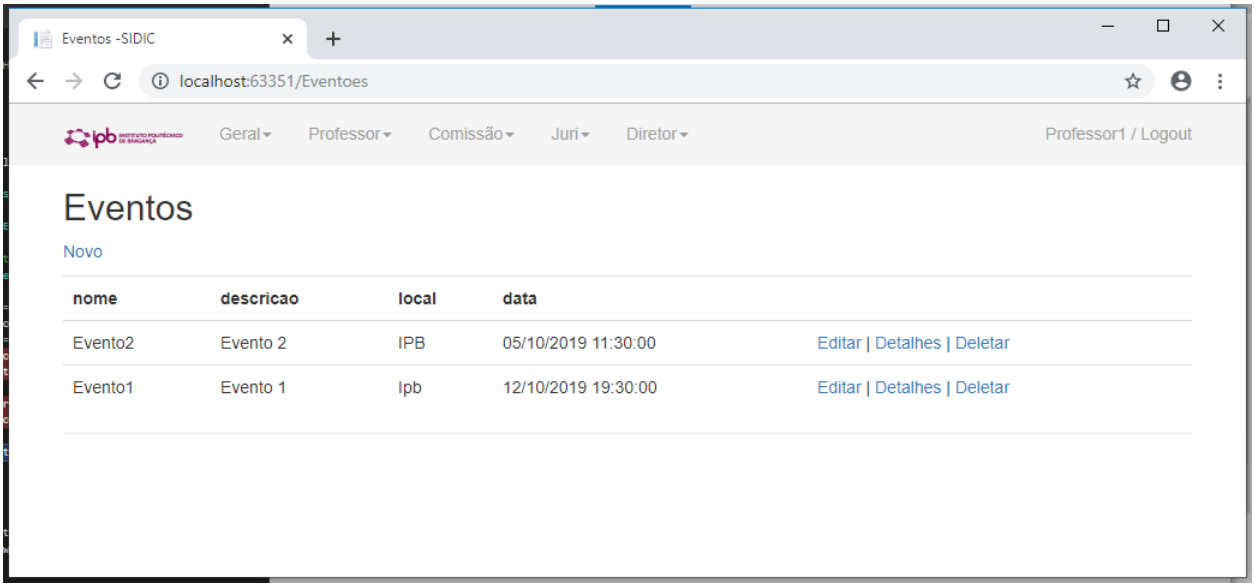

Figure C.9: Events

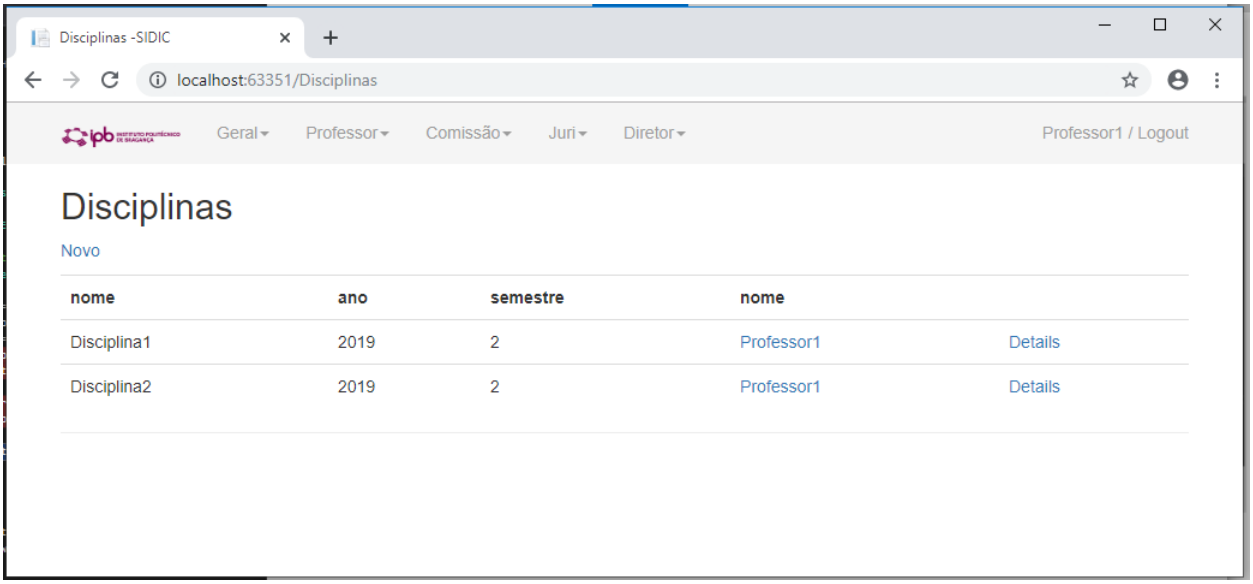

Figure C.10: Subjects

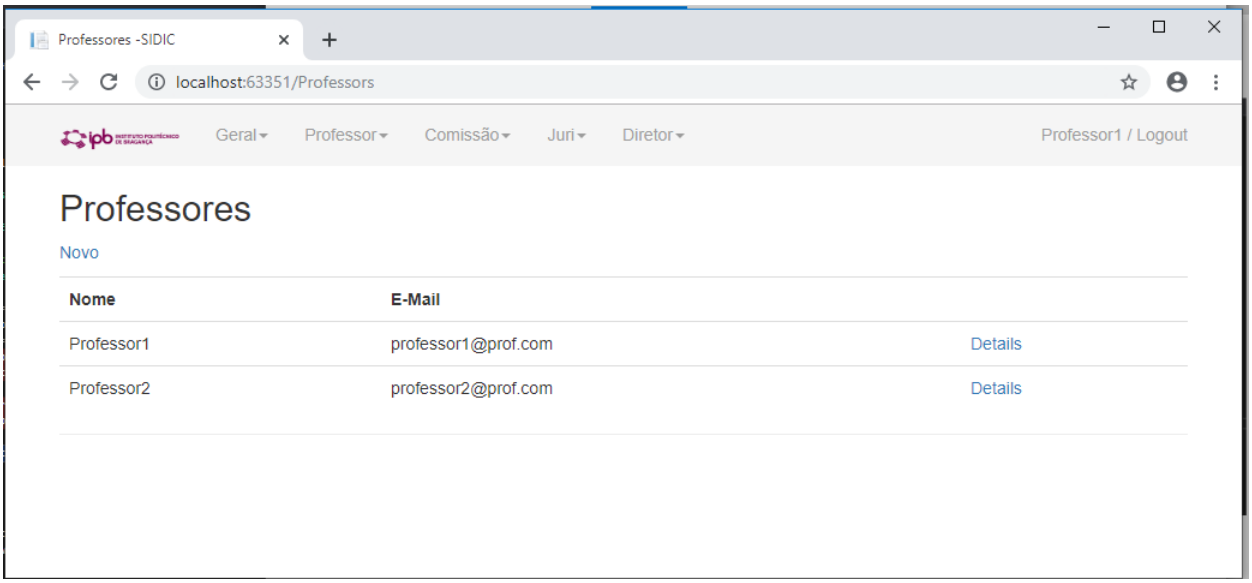

Figure C.11: Director View Professor

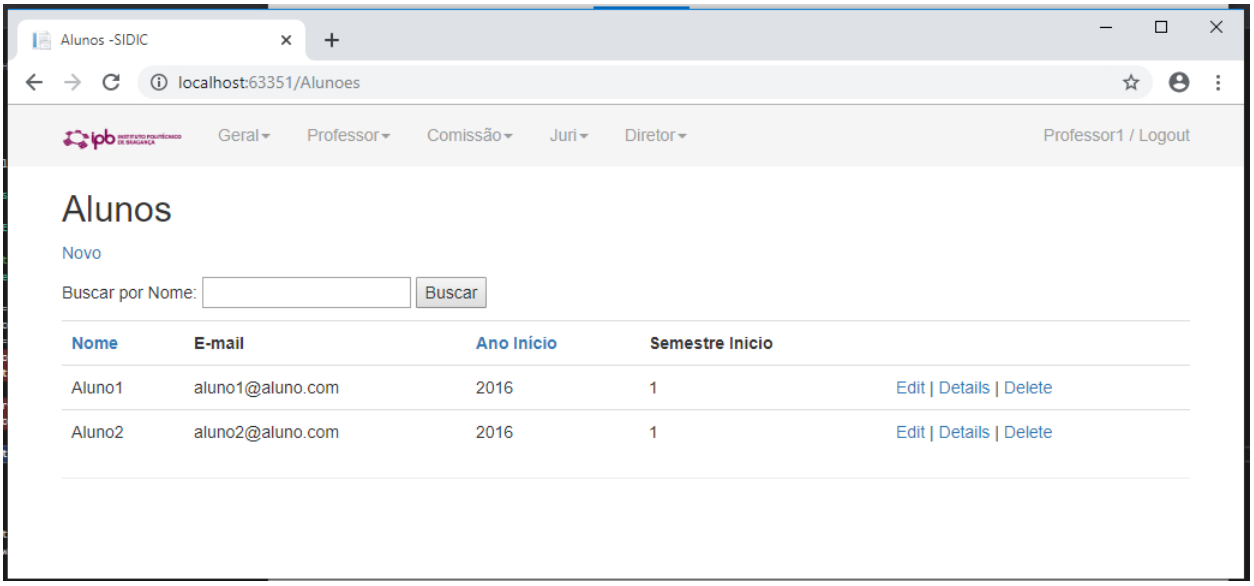

Figure C.12: Director View Student