
# Business Process Automation in the Academic Context

**Sofia Apolónia Pereira de Sousa - a35482**

Thesis presented to the School of Technology and Management in the scope of the Master in Informatics.

Supervisors:

Prof. José Eduardo Moreira Fernandes

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# Dedication

I want to dedicate this dissertation to my family, especially my parents, Domingos and Clara, and my grandparents, José and Emília, who were always by my side, supporting and loving me, and never let me give up.

Secondly, to my great friend of the heart Paulo Pereira who supported me and was always by my side in the happy moments and in the most difficult ones, but who always believed that I could reach my goals and dreams.

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A special thanks to my supervisor, José Eduardo Fernandes, who guided me along this path.

# Abstract

Nowadays organizations invest their time to improve the execution of their processes in order to also improve the use of their resources.

In the academic context, many processes are executed, from the dissemination of proposals, to the enrollment of new students in the educational institution, to the delivery of dissertations/internship/project reports, or even international mobility programs that require accuracy throughout the process flow.

In order to improve this procedure logistics, different Business Process Management System (BPMS) were explored in order to understand which would be the most suitable to be applied in an academic context, as well as to select the most appropriate one for that purpose.

This document aims to assess whether the automation of a process at the academic level is viable. For this, an existing process was selected, in this case the submission and evaluation of a dissertation report, which in turn was applied in the form of a Business Process Model and Notation (BPMN) diagram and proceeded to automate it using a BPMS.

**Keywords:** Academic Context, Processes, BPMS, BPMN

# Resumo

Nos dias de hoje as organizações investem o seu tempo de forma a melhorar a execução dos seus processos com o objetivo de também melhorar o uso dos seus recursos.

No contexto académico, são executados muitos processos, desde a divulgação de propostas, à inscrição de novos alunos na instituição de ensino, como à entrega de dissertações/relatórios de estágio/projeto, ou até mesmo programas de mobilidade internacional que requerem rigor ao longo de todo o fluxo do processo.

Com o objetivo de melhorar esta logística de procedimentos, foram explorados diferentes Sistema de Gestão de Processos de Negócios (SGPN) de forma a perceber qual seria mais indicada para ser aplicada em contexto académico, assim como selecionar a mais adequada para tal efeito.

Neste documento tem como objetivo avaliar se a automação de um processo a nível académico é viável. Para isso, foi selecionado um processo existente, neste caso da Submissão e avaliação de um relatório de dissertação, que por sua vez foi aplicado em forma de diagrama Modelo e Notação de Processos de Negócio (MNPN) e que se procedeu à automação do mesmo, utilizando um Sistema de Gestão de Processos de Negócios SGPN.

**Palavras-chave:** Contexto Académico, Processos, Sistema de Gestão de Processos de Negócios, Modelo e Notação de Processos de Negócio.

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# Acronyms

**AES** Automated Essay Scoring

**AI** Artificial Intelligence

**API** Application Programming Interface

**ASAP** Automated Student Assessment Prize

**BERT** Bi-directional Encoder Representations and Transformers

**BMN** Business Management Notation

**BP** Business Process

**BPA** Business Process Automation

**BPM** Business Process Management

**BPMI** Business Process Management Initiative

**BPMN** Business Process Model and Notation

**BPMS** Business Process Management System

**CMMN** Case Management Model and Notation

**CRM** Customer Relationship Management

**DMN** Decision Model and Notation

**DPA** Digital Process Automation

**EML** Extensible Markup Language

**ERD** Entity Relationship Diagrams

**ERP** Enterprise Resource Planning

**HTML** HyperText Markup Language

**IBM** International Business Machines

**ICT** Information and Communication Technologies

**IDE** Integrated Development Environment

**IT** Information Technology

**JDK** Java Development Kit

**JRE** Java Runtime Environment

**LMU** Linguagem de Modelagem Unificada

**ML** Machine Learning

**MNPN** Modelo e Notação de Processos de Negócio

**OMG** Object Management Group

**ORMD** Object Relational Mapping Diagrams

**PDF** Portable Document Format

**PM** Process Modelling

**QWK** Quadratic Weighted Kappa

**REST** Representational State Transfer

**RPA** Robotic Process Automation

**SAT** Scholastic Aptitude Test

**SBLSTMA** Siamese Bidirectional LSTM Neural Network Architecture

**SDK** Software Development Kit

**SGPN** Sistema de Gestão de Processos de Negócios

**UI** User Interface

**UML** Unified Modeling Language

**XPDL** XML Process Definition Language

# Chapter 1

# Introduction

Over the years, the human being has been looking for ways to facilitate and improve his work obtaining the desired efficiency. Consequently, the need came for the creation of auxiliary tools so that it would then be possible to perform the laborious or repetitive work in an easier way.

The evolution of organizations has grown exponentially, and process automation is one of the results of this evolution. Currently, there are more and more areas that benefit from the use of automation, one of which is the Business Process (BP).

The application of automation in the BP provides a revolution in this area, as it provides added value to those who want to better understand the multiple business processes that exist in a fast and simple way.

Automation is the use of systems and/or technology to perform operations with little or no human involvement. It involves the use of equipment, software, or other tools to perform repetitive or routine tasks, increasing throughput, efficiency, and accuracy.

Business Process Management (BPM) is a structured, results-oriented approach to improve the efficiency, quality, and agility of an organization's processes, with the goal of enhancing customer experience, reducing costs, and gaining competitive advantage. Since this is an area that, like many others, is constantly evolving, automating these processes makes perfect sense to make it easier and more agile to get work done in an academic institution or any other organization quickly and easily.

The use of tools in the daily life of human beings is increasingly frequent and useful. In this way, institutions may also need to take advantage of resources that help them.

Thus, the main objective of this dissertation is to understand how the use of process automation tools can be useful in the academic context in order to streamline processes that exist in this same context. In addition, assess which tool is the most suitable for academic use.

## 1.1 Document Structure

This document is organized by chapters as follows: In the second chapter, the existing technologies, concepts and studies that exist in the area of business processes are described. In chapter 3, the problem in question is developed and a proposal for its solution is elaborated. In chapter 4 a practical case is implemented. Finally, in chapter 5 the discussions and analysis are carried out.

# Chapter 2

# Context and Technologies/Tools

Some challenges, systems and solutions that exist within the scope of the theme will be presented, as well as a brief explanation of the involving tools. In addiction, some studies will be presented surrounding automation in the academic context.

## 2.1 Business Process Fundamentals

For this section it is important to understand the concepts surrounding BP, since to automate it is necessary to know it, so this section aims to explain some key concepts of BP, discuss about automation and its beginnings, along with the challenges and opportunities.

### 2.1.1 Business Process

Adam Smith, Thomas Davenport, Frederick Taylor, and Peter Drucker had a major impact on how organizations currently define and deal with the term BP. In 1776, Adam Smith was the first to recognize that dividing work into a set of tasks performed by specialists could lead to increased productivity [1].

Based on Adam Smith's definition, a BP is a set of tasks that are linked and when, once completed, will fulfill an organizational purpose. This process involves clearly defined inputs that are composed of all the factors that will contribute to the value of the service

or product, to obtain a single output. Since the creation of the BP concept, areas of study such as operations management and business management were developed, which in turn were responsible for creating a Business Process Management System BPMS industry seeking to automate the management of these processes, uniting several process points with the help of technology [2].

### 2.1.2 Business Process Management

"Business Process Management is the art and science of overseeing how work is performed in an organization to ensure consistent outcomes and to take advantage of improvement opportunities" [3]. It examines the situation as it is now and points out possibilities for development in order to build a more effective and efficient organization. Within a company there are often many complex processes and a amount of information, and disorganization and lack of systematization in handling them can lead to chaos.

There are six process stages of a BPM lifecycle, illustrated in Figure 2.1, which are: identification, discovery, analysis, redesign, implementation and monitoring[3].

- **Process identification**: The initial phase where a business problem is presented and assessed. The processes that are pertinent to the addressed problem are recognized, defined, and interconnected, and the result of this phase is the creation or update of a process architecture, which offers a comprehensive view of the organization's processes and their interdependencies. This architecture is to determine which specific process or set of processes will be managed throughout the remaining stages of the lifecycle.

- **Process discovery**: Also known as process modeling, involves documenting the existing state of each relevant process. This documentation is usually accomplished through the creation of one or multiple process models.

- **Process analysis**: The phase where issues related to the process are identified, documented, and, whenever feasible, quantified using performance measures. The

result of this phase is a structured compilation of issues, which are then prioritized based on their potential impact and the estimated effort needed for resolution.

- **Process redesign**: Also known as process improvement, aims to identify changes that address identified issues and help the organization achieve performance goals. Multiple change options are analyzed and compared based on performance measures. The most promising options are selected and combined into a redesigned process, resulting in a to-be process model.

- **Process implementation**: It covers the preparation and execution of changes needed to go from the current as-is process to the desired to-be process. It involves two vital aspects: organizational change management and process automation. Organizational change management involves transforming the work practices of all participants in the process, while process automation focuses on developing and deploying IT systems to support the to-be process.

- **Process monitoring**: Is the ongoing phase where the implemented redesigned process is continuously observed. Relevant data is collected and analyzed to assess the performance of the process in relation to its performance measures and objectives. This analysis helps identify bottlenecks, recurring errors, and deviations from the intended behavior. Corrective actions are then taken to address these issues. It's important to note that as the monitoring progresses, new issues may emerge, either within the same process or in other processes, requiring a continuous cycle of monitoring and improvement.

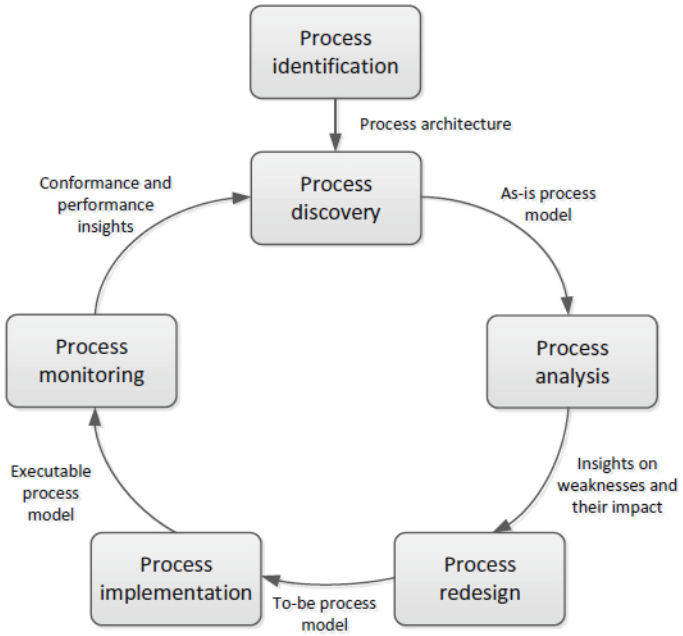


Figure 2.1: BPM Lifecycle [3].

### 2.1.3 Business Process Modeling

The analytical depiction, or simply expressed, an illustration, of a company's business operations is known as BP Modelling (or Process Modelling (PM)). PM is a vital part of efficient business process management.

PM provides genuinely objective views of workflows as they actually occur in practice, as they are based on quantitative data. This includes important data, measurements or events that could have been missed. Typically, PM are displayed using Unified Modeling Language (UML) or BPMN, two standard types of business process graphical notation. In addition, when used in a PM, specific visual components of these notation systems have widely understood meanings [4].

Team members can examine a workflow from a variety of angles thanks to the variety of workflow data that can be found in a single process model. Control flow, organization, case and time are four key workflow components that business analysts frequently focus on using business process modeling.

### 2.1.4 Business Process Management System

A BPMS is a comprehensive software tool used to effectively manage and automate process flows. With this, users can visually model and design their processes, automate workflows, assign tasks to individuals or systems, monitor process performance in real-time, and make data-driven decisions for process optimization.

With the help of these systems, users can visualize their processes, monitor and track the execution of the entire process in a simple and fast way. In addition, it allows users to define different business rules and what routing conditions they want to have in their processes. These tools also have the advantage of speeding up the execution of the entire process flow. Selecting the right and most suitable tool to produce faster results is crucial for the company to get better results.

### 2.1.5 Business Process Model and Notation

The BPMN is a visual modeling language that allows to specify BP in a BP diagram. The purpose of creating this language is to support the modeling of business processes, offering its users the representation of complex processes semantics through a simple and easy to understand notation.

BPMN is the result of combining various business modeling notations. Since the two organizations joined in 2005, BPMN has been managed by Object Management Group (OMG) and was then first launched by the Business Process Management Initiative (BPMI) in 2004. After that, the OMG and BPMI merged. BPMN 2.0 was created in 2010, and the official release of the specification took place in December 2013.

Companies and organizations can gain many benefits from business process modeling, such as the simplicity of understanding and the ability to illuminate the potential complexity of a business process. It gives companies the ability to use business process diagrams to define and comprehend their processes and offers a common notation that all company stakeholders can easily grasp. It also fills the communication gap that typically exists between the design and implementation of business processes. Finally, it gives

companies a business standard created by the OMG consortium, which is a non-profit business organization.

To be able to build a diagram it is necessary to know the surrounding symbology and the basic categories that exist are Swimlanes, Flow Elements, Connecting Objects and the Artifacts [5].

### Swimlanes

**Pools** represent processes and participants in the process and each pool has several **lanes**, which symbolize roles, areas and responsibilities in the process (figure 2.2) [6].

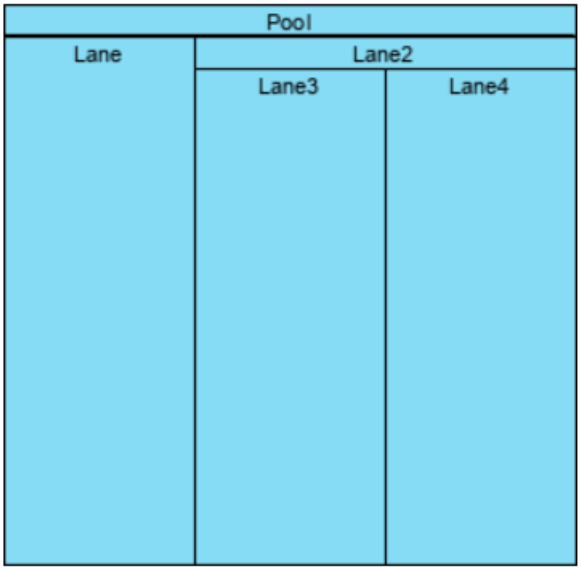


Figure 2.2: Pool and Lanes [6]

### Flow Elements

The main components that determine how a process behaves are known as flow elements because they connect to one another to construct business processes. **Events** (figure 2.3), **Activities** (figure 2.4), and **Gateways** (figure 2.5) are the three different categories of flow elements. Circles are used to depict **Events**, which are things that happen. **Activities** are represented by squares and stand for work that is completed or anything

that is done and, the diamond-shaped diversion spots known as **Gateways** will decide the process's course [6].

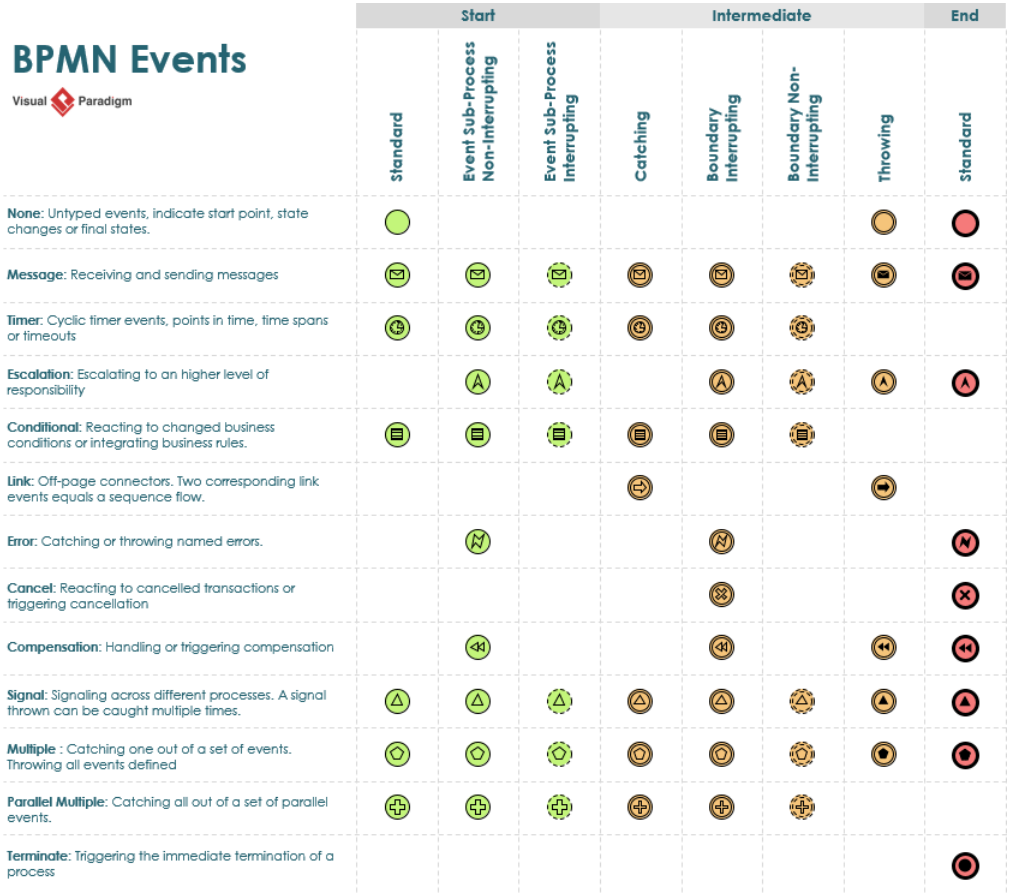


Figure 2.3: Events [6]


Figure 2.4: Activities [6]


Figure 2.5: Gateways [6]

### Connecting Objects

In order to create a flow, flow objects are not isolated, but rather linked together. Connecting Objects are the connectors that link the flow objects (figure 2.6). The **Sequence Flow** shows in what order activities are performed, and is symbolized by a solid line and an arrow ahead. In turn, the **Message Flow** indicates which messages flow between two processes/pools, and is represented by a dashed line, an open circle and an open arrow at the end. Finally, the **Association** that is responsible for connecting the artifacts to the flow objects is symbolized by a dashed line [6].

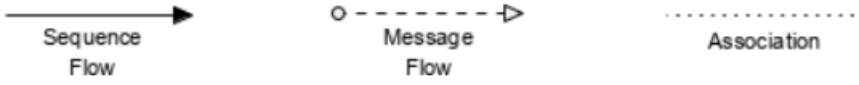


Figure 2.6: Connecting Flows [6]

### Artifacts

Artifacts are utilized to enhance the diagram's visual documentation. Data objects, which explain how data can be processed, are one of the key components of BPMN. They could be **data objects**, **data stores**, **inputs**, or **outputs** (figure 2.7) [6].


Figure 2.7: Artifacts [6]

## 2.1.6 Business Process Automation

The beginnings of automation date back to the 1$^{st}$ century B.C. with the creation of the water wheel (figure 2.8) that was developed to drive a mechanical process through the force of water, so that it was possible to grind cereal grains into flour. Around the 7$^{th}$ and 9$^{th}$ centuries, the Persians developed the first windmills, and later they were developed for other mechanical processes. These mills, both water and wind, were adopted all over the world by locksmiths, mines, and even for sharpening tools.

Figure 2.8: Norias of Hama. [7]

With the industrial revolution came steam engines and mills, and beyond that internal combustion engines. In 1785 the first fully automated industrial process in history was conceived, allowing humans to have continuous production without any human intervention. This human achievement was accomplished by Oliver Evans by creating an automatic flour mill. The industrial revolution provided the leverage needed for the process of electrification to begin the transition to electric motors, achieving a 30 percent increase in existing factory output. As technology advanced, so did automation, making robotic processes more relevant in the industry. In 1969 the "*Stanford Arm*" was created by pioneer Victor Scheinman (figure 2.9), opening the door to the complexity of tasks that robots could perform, such as welding and assembly.[8]

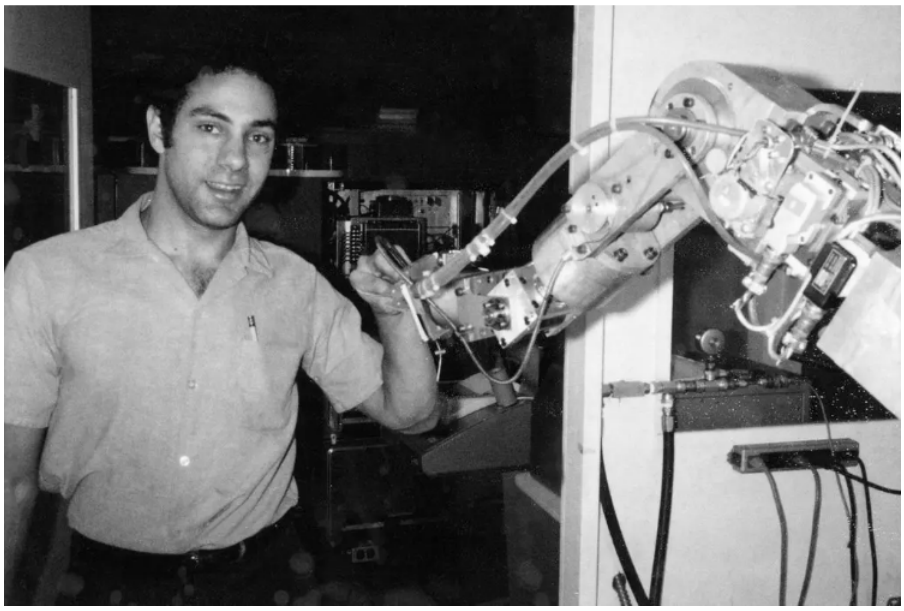

Figure 2.9: Victor Scheinman and the robot "Stanford Arm". [9]

Over the years, the increase in business productivity and the cost-saving benefits of BP software solutions have led to a search for new and improved technologies that simplify complex BP. Thus, in 2010, Digital Process Automation (DPA) was developed. This allows companies to automate one or more tasks involved in a process using technologies such as Machine Learning (ML), Robotic Process Automation (RPA) and Artificial Intelligence (AI).[10] As a result, DPA operates on low-code platforms, which allow users to easily automate their processes and increase productivity.

The use of technology to automate repeatable, day-to-day processes is known as Business Process Automation (BPA). It improves productivity by routing information to the appropriate person at the appropriate time using user-defined rules and actions. BPA assists businesses in streamlining procedures like as onboarding new employees, accounts payable, contract administration and in this case the academic context.[11]

### 2.1.7 Relevance, Challenges and Oportunities

All organizations aim to take advantage of the resources that exist in order to obtain the highest possible profit margin as efficiently as possible. In this way, automation is considered an ideal solution to achieve this goal and avoid waste and reduce costs by taking advantage of technology to increase operational efficiency.

Although there is an initial resistance towards automation in companies, the benefits of it are remarkable. Some of the benefits are the reduction of human work because it is possible to automate various processes such as sending emails, customer support chats, among others. This frees employees from routine task execution and allows them to focus more on more critical functions. Despite this, automation also allows the reduction of human error that sometimes occurs with the manual tasks of employees. Operational stability is also another benefit, as automation creates stability by eliminating errors and implementing strict guidelines in processes, providing more reliable and accurate processes. Consistent customer service ensures the same level of service to customers at any time of day. Operational costs are reduced because process automation also improves

employee efficiency and reduces errors. Productivity is increased because the workload is alleviated by improving productivity, and reliability is also in turn improved by making internal processes predictable and easy to analyze, establishing a sequence for jobs, and executing each task successfully with minimal errors.

Despite automation bringing greater efficiency and productivity to organizations, there are still obstacles to face in automating processes. One of the obstacles is the employees themselves, who consider automation as a threat and therefore resist it. One solution is to clearly communicate the benefits of automation and how it will improve the safety and productivity of each employee.

The cost is also one of the biggest obstacles of automation for companies, since they incur very high levels of costs and require a lot of maintenance and improvements. However, after all the necessary implementation has been carried out, in the long run, the cost savings outweigh the initial outlay.

In addition to the obstacles presented previously, the lack of qualified professionals is also a major obstacle. This is because, in addition to automation, reducing dependence on human work creates the problem of having qualified professionals to deal with this newly acquired technology, making organizations need to hire qualified personnel and, in addition, train them properly [12].

The introduction of automation beyond industries and companies has also created the opportunity for other areas to start their journey in automation, carried out in the fields of robotics, medicine, finance, purchasing, product management, facilities, sales, human resources, legal, operations, marketing, security, and communications. Every business must automate and adapt to the world's rapid technological advancement [13].

## 2.2 Works on automation in the academic context

Currently, the improvement of processes in various sectors such as industry, robotics and even health is a growing concern for everyone, and the improvement of these processes within our educational institutions is no exception. This is not only to improve the

functioning of the institutions but also to streamline these processes for those involved in the processes, from students to teachers and employees. As such, there are already some studies concerning the automation of processes in the academic context.

Jose L. Valverde, Victor R. Ferro and Anne Giroir-Fendler saw an opportunity in the use of Aspen HYSYS, a tool typically used in some Master's courses in Chemical Engineering at the University of Castilla-La Mancha, which serves for "Analysis and Optimization of Chemical Processes" and "Process Dynamics: Regulation of Chemical Facilities". They proposed that the University of Castilla-La Mancha should hold a seminar about automation based on the study of two cases: a refrigeration process and a production process taken from the literature. After analyzing the results, the students considered the methodology of the course and the potential of automation for the development of their skills in an appropriate way, which turned out to be very positive. However, more examples were found to be necessary to better understand the concept of automation and its potential application to other situations, as well as a deeper knowledge about automation and programming [14].

Another study on automated essay classification using machine learning aimed to examine automated methods of assay evaluation. To do this they used a PRISMA Flow Diagram to conduct a systematic review of the literature. To do this they collected information pertinent to the studies research topics and processed that information to provide a response. The performance score of models using the same data they used to compare them. According to the studies they found, Automated Essay Scoring (AES) uses feature engineering and deep learning as their two main methodologies. In addition they realized that these studies also use the average Quadratic Weighted Kappa (QWK) and Automated Student Assessment Prize (ASAP) dataset as performance metrics realized that Siamese Bidirectional LSTM Neural Network Architecture (SBLSTMA) and Bidirectional Encoder Representations and Transformers (BERT) + handcrafted-features, are thus the models with the highest performance score on ASAP datasets [15].

The paper "Automated Essay Scoring and the Search for Valid Writing Assessment", discusses the importance of place-based and context-sensitive assessment in education,

especially in writing courses. In the context of the New Jersey Institute of Technology, assessment has traditionally been done using measures such as Scholastic Aptitude Test (SAT) Writing and teacher evaluation, and the collection of student work in portfolios for program assessment. However, new technologies, such as AES systems and electronic portfolios, offer alternative approaches to assessment. These innovations reflect the emphasis on writing in digital environments in the 21st century [16].

With this overview of different studies it is possible to observe that the application of automation in the academic context has already been considered and applied in order to verify if it is viable and advantageous. With this it can be concluded that it is possible to apply automation in the academic context and that there may be more processes that automation can bring benefits.

# Chapter 3

# Business Process Management Systems Analysis

Some tools that are currently used for creating business processes will be described, as well as the benefits that each tool brings to its users and what important utilities they bring to academic use.

## 3.1 Business Process Management Systems

BPMS are increasingly useful for companies to design a systematic approach in order to optimize their business processes. Companies turn this systems to implement, model and automate workflows in order to improve performance, minimize human errors, control costs and productivity failures, making daily processes as efficient as possible to ensure the effectiveness of the people involved in these same processes.

Due to the vast amount of systems available for the automation and optimization of these processes it is necessary to make a comparison between them, in order to attempt to understand which one is the most suitable to be applied in this work. Thus, a short analysis will be made of some of the best known tools available in the market.

### 3.1.1 Camunda

In 2008, Bernd Rücker and Jakob Freund founded Camunda as a BPM consulting firm, to address the challenges they faced while working on process automation projects for their clients. They saw a need for a more flexible and efficient BPMN-based workflow engine, and so Camunda was born as a platform for workflow and process automation. The goal of Camunda was to make it easier for organizations to automate their business processes and gain greater visibility and control over their operations.

Currently, the tool provides a graphical tool for designing, executing, and testing BPMN 2.0 processes. Task management and assignment allows users to handle and delegate human tasks with due dates and assignments. Users can generate and manage user task forms with multiple form types. Camunda offers an integration framework to connect external systems and execute tasks within workflows. Real-time monitoring, rule and event-based process execution, and history tracking features are available. Decision Model and Notation (DMN) and Case Management Model and Notation (CMMN) standards are supported. Users can manage process-related documents and files with versioning and access control. User roles and permissions can be managed to control access. Camunda supports multi-tenancy and the migration of process instances between tenants. In addition Camunda provides a Representational State Transfer (REST) Application Programming Interface (API) and Software Development Kit (SDK) for custom extensions and integration. [17]

Camunda provides a Community edition and an Enterprise edition of its platform. The Community edition is free and open-source, offering features such as workflow modeling, task management, forms, integration frameworks, monitoring, rule-based execution, history tracking, standards support, document management, user management, multi-tenancy, and REST API. The Enterprise edition provides additional features such as scalability, high availability, clustering, advanced user management and authorization, reporting, extended BPMN support, document management, and dedicated support. The pricing for the Enterprise edition varies based on the required support and number of

users [18].

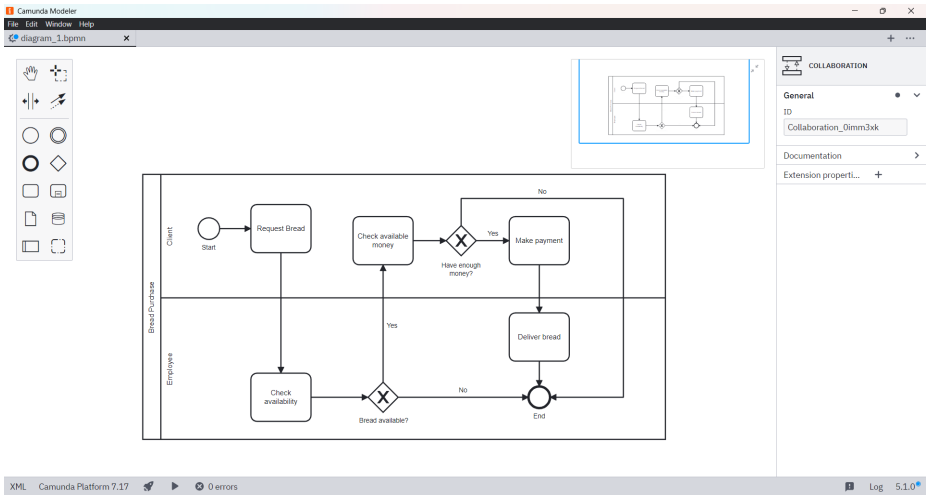


Figure 3.1: Camunda.

### 3.1.2 ProcessMaker

When Bobby Vernon and Brian Reale attempted to launch *spinsit.com*, an online reinsurance trading platform, ProcessMaker was born.

As the project progressed, it became evident that there was a demand for technologies that would eliminate the need for paper approvals. Paper forms and complex procedures were overwhelming institutions and major corporations all around the world. To set themselves apart, the team decided to create an open source product. They recognised that enterprise workflow software was ripe for upheaval, and that Open Source would emerge as a new force in enterprise software. Soon after, the Process Maker BPM brand was formed [19].

ProcessMaker is a low-code platform for digital process automation. It allows users to create, automate and optimize business processes using a visual drag-and-drop interface. With ProcessMaker, organizations can streamline their workflows, reduce errors and increase efficiency by eliminating the need for manual paper-based processes.

The platform also includes tools to create custom forms, collect and manage data, and integrate with external data sources. It provides tools for managing complex cases

with multiple steps and stakeholders, and robust reporting and analysis tools for insight into process performance. ProcessMaker includes features for managing users, groups and permissions, ensuring authorized access to sensitive information, as well as collaboration and communication tools such as feedback, notifications, and messaging. It also supports integration with Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems, and provides mobile access for users to access workflows and data from anywhere with an Internet connection. ProcessMaker has strong security features, such as role-based access control, encryption, and audit trails for data protection.

The pricing model is determined by the plan selected and the number of users. The plans available include a free option, a community plan, and various business plans. The prices for each plan are influenced by factors such as the number of users, the length of the contract, and the discounts offered. Business plans are typically priced per user, per month, and can range from a few hundred to several thousand dollars per month, depending on the features and number of users included [20].

Overall, ProcessMaker provides a comprehensive set of features that allow users to design, automate and optimize complex workflows and business processes, reduce costs, increase efficiency and enhance collaboration across teams and departments.

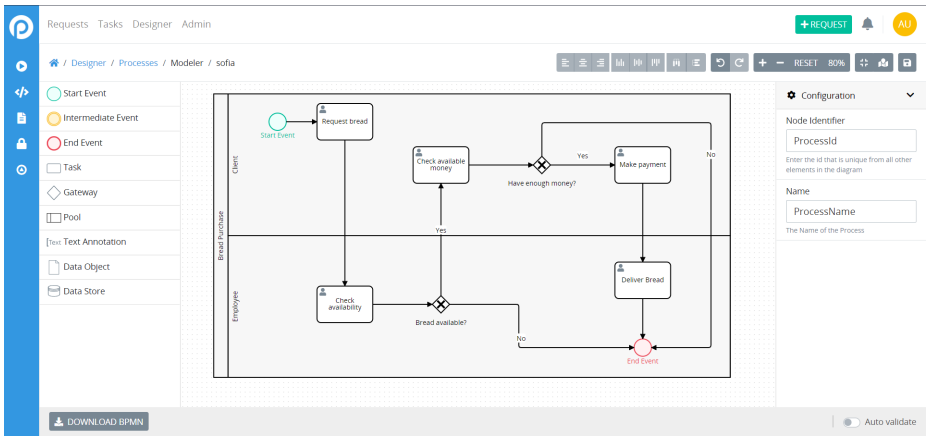


Figure 3.2: ProcessMaker.

### 3.1.3 Heflo

Initially founded on May 1, 2002 as an outsourcing company for information systems maintenance, in 2015, the same company launched Heflo, a cloud-based platform for process automation and workflow management [21].

Heflo allows to design and manage workflows visually, define process steps, and establish rules for delegating and completing tasks. In addition, it allows to assign tasks to specific individuals or teams and track their progress in real time. The tool also sends automatic notifications and reminders to keep team members informed, and provides a centralized repository for storing and managing workflow-related data and files, with options for capturing, searching, and retrieving data. Forms can be customized for data entry and reporting functions to track process performance and identify areas for improvement. Heflo integrates with many other tools and systems, such as CRM, ERP, and project management tools, to streamline workflow and increase efficiency. It allows administrators to manage user accounts and set permissions to control access to specific workflows and data. In addition, mobile apps are available for iOS and Android, allowing users to access and manage workflows anytime, anywhere [22].

With Heflo it is possible to have a business plan, or there is also a plan for students that gives them access to features such as adding collaborators and uploading attachments to the diagram. There is also a version control option for increased security [23].

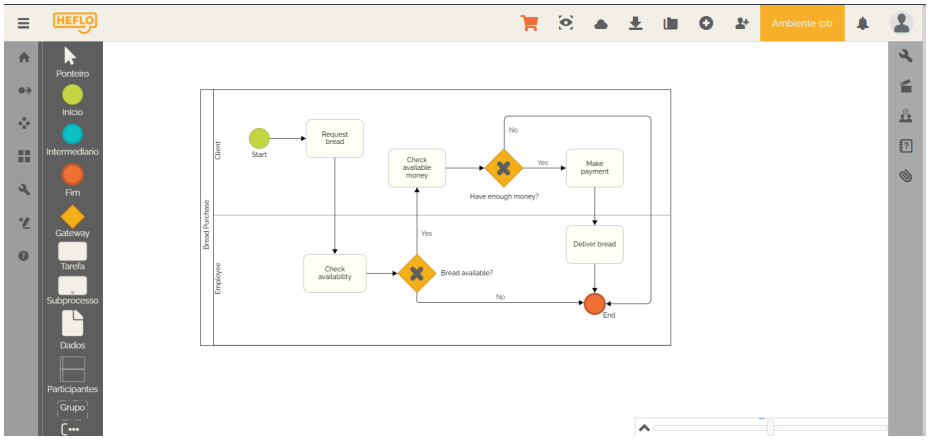


Figure 3.3: Heflo.

## 3.2 Adoption of Process Automation Systems

The adoption of tools for people's work has facilitated human beings in their day-to-day functions and tasks. In this context, admitting the use of tools in an academic context may also be important for those who need to streamline processes.

### 3.2.1 The Academic Context

University organization members, researchers, and students must all complete a variety of responsibilities in the dynamic and complicated academic environment. In order to streamline processes, increase productivity, and raise the level of output, the use of automation technologies has grown in popularity in this context over the past few years.

The challenge of describing the academic context from the standpoint of adopting automation tools is complex and encompasses many facets of the environment. The type of tasks that are often performed in the academic context is one of the most important dimensions. These tasks can be as simple as enrolling in classes or turn in tasks for more involved research projects, such as data analysis or scientific writing. Thus, they can be simplified and improved with the help of automation tools.

The individuals that make up this scenario, or its actors, are another crucial aspect of the academic context. The key players in this situation are university organization members, researchers, and students, each of whom have unique desires and demands. For example, while students may gain from tools that make it easier to manage their academic schedules or create study materials, researchers would need automated tools to perform data analysis or literature reviews. As a result, when adopting automation solutions, it is important to consider the variety of users and their unique characteristics.

Due to its high level of specialization and complexity, the academic context is also characterized by the need for specialized knowledge and skills by its actors. University organization members and researchers, for example, need to have knowledge of various computer languages, statistical software, and research procedures. By offering interactive tutorials, simulations, or other learning resources, automation technologies can be used

to assist in the acquisition and development of these skills.

In conclusion, a multifaceted and thorough analysis that considers various facets of this environment is necessary to characterize the academic context from the point of view of the use of automation tools. It is possible to design and implement automation tools that effectively support and enhance the work of University organization members, researchers, and students by understanding the needs, challenges, and opportunities of the academic context.

### 3.2.2 Most Suitable Tools for the Academic Context

After the analysis performed on the most suitable tools for use in an academic context, it is then possible to conclude that all of them are really useful and efficient because, as for the modeling part, they all meet the BPMN 2.0 specifications.

Since it is necessary to choose one of these tools to develop the BPMN, a table was created with the most relevant aspects of each of the tools and which aims to compare them. This table was based on the work developed by João Gris [24].

One of the main points taken into consideration for the choice was the complete range of available platforms, and the search for a tool independent of the company's external servers would be of great importance. With this, Heflo is then excluded from the choice as it is only available for use online, and all content is stored on private servers.

Due to their compatibility with the requirements and ability to provide a good solution to the issue, the latter two programs are both very capable. Both offer support on the desired platforms as well as good support for features that may be interesting for the process that is intended to be applied, such as the integration of external services.

However, one of the key reasons to select one system over the other is the ease of use. Camunda provides a good and simple user interface, allowing a great learning curve. For these reasons, and because Camunda has already been used in previous experiences, such as Business Process Engineering class, it was selected for the application of a BPMN process.

| Feature | Camunda | Process Maker | Heflo |
|---|---|---|---|
| Facility for process drawing | Yes | Yes | Yes |
| Possibility to attach information to the activities (business rules, generated documents) | Yes | Yes | Yes |
| Integration with database and external systems | Yes | Yes | Yes |
| User experience | Good user experience | Medium user experience | Medium user experience |
| Process simulation and execution | Yes | Yes | Yes |
| Use standards symbology notation | Yes | Yes | Yes |
| Compatible with Linux | Yes | Yes | No |
| Compatible with Windows | Yes | Yes | No |
| Compatible with WEB | No | No | Yes |
| Installation file size | 230MB | 147.9 MB | 0MB |
| Prices | Free Version available | Free Version available | Free Version available |

Table 3.1: BPMS Comparison.

# Chapter 4

# Practical Case of Application

Nowadays, we find more and more complex processes around us that are important to our society. Several institutions need to have an organized process flow that allows them to present greater efficiency and agility in their procedures. The integration process in a company is an extremely important process, not only for the new employee, but also for the organization that welcomes the new hire. For online shopping, there is also a need for a procedural flow that allows the delivery of orders to the consumer's home correctly and quickly.

When focusing on a more academic side, there is also many imperative process flows such as the case of the enrollment of a new student in the educational institution, where it involves the delivery and receipt of documentation and the whole process must be done in an agile and fluid way by both the student and the academic services. For students who intend to go on Erasmus, there also needs to be a set of processes that are carried out diligently and thoroughly. There are also a variety of errors that can occur if the processes are not properly organized and streamlined. Another example of a complex process is the submission of the dissertation, project or internship report and the corresponding trials realization. The whole process is extensive and time-consuming, and requires special care on the part of all those involved. This procedure is also frequently used in educational institutions due to its high relevance. Those reasons were the main factors for choosing to implement this process in the BPMS.

So, it began by developing the process in a UML activity diagram in order to achieve a general view of how it is structured and what interactions occur between the various entities. After this, it was applied in a BPMN diagram with the objective of automating the complete process. Discussions and comparisons regarding these two diagrams will be made later in the following chapter.

## 4.1 Business Process Modeling

For the report submission process it was possible to access the document issued by the "Diário da República" that presents in its regulations the Normas "Regulamentares dos Mestrados do Instituto Politécnico de Bragança" [25]. With this, it was then possible to follow a process model that is currently implemented by an educational institution.

In order to better understand this entire process flow, from submission to posting to the final grade, it was necessary to build an UML activity diagram. This diagram allowed to understand which processes existed and how they interconnected, as well as the entities that needed to intervene during the flow. It seems like a simple process to present, but it involves several steps and intermediate entities that we often don't realize happen, represented in purple, and that are significant to the whole flow. The process starts from the moment the student submits his or her work (figure 4.1).

After submission, the academic services verify if the student's conditions are met, such as, for example, complete approval in the curricular units that make up the master's course (connector A). If all the conditions are not met in order to proceed with the process, then the student will be informed that his submission is invalid. After this verification, the Scientific Committee of the Course receives a notification that there was a submission and with that a Jury proposal is initiated (figure 4.2).

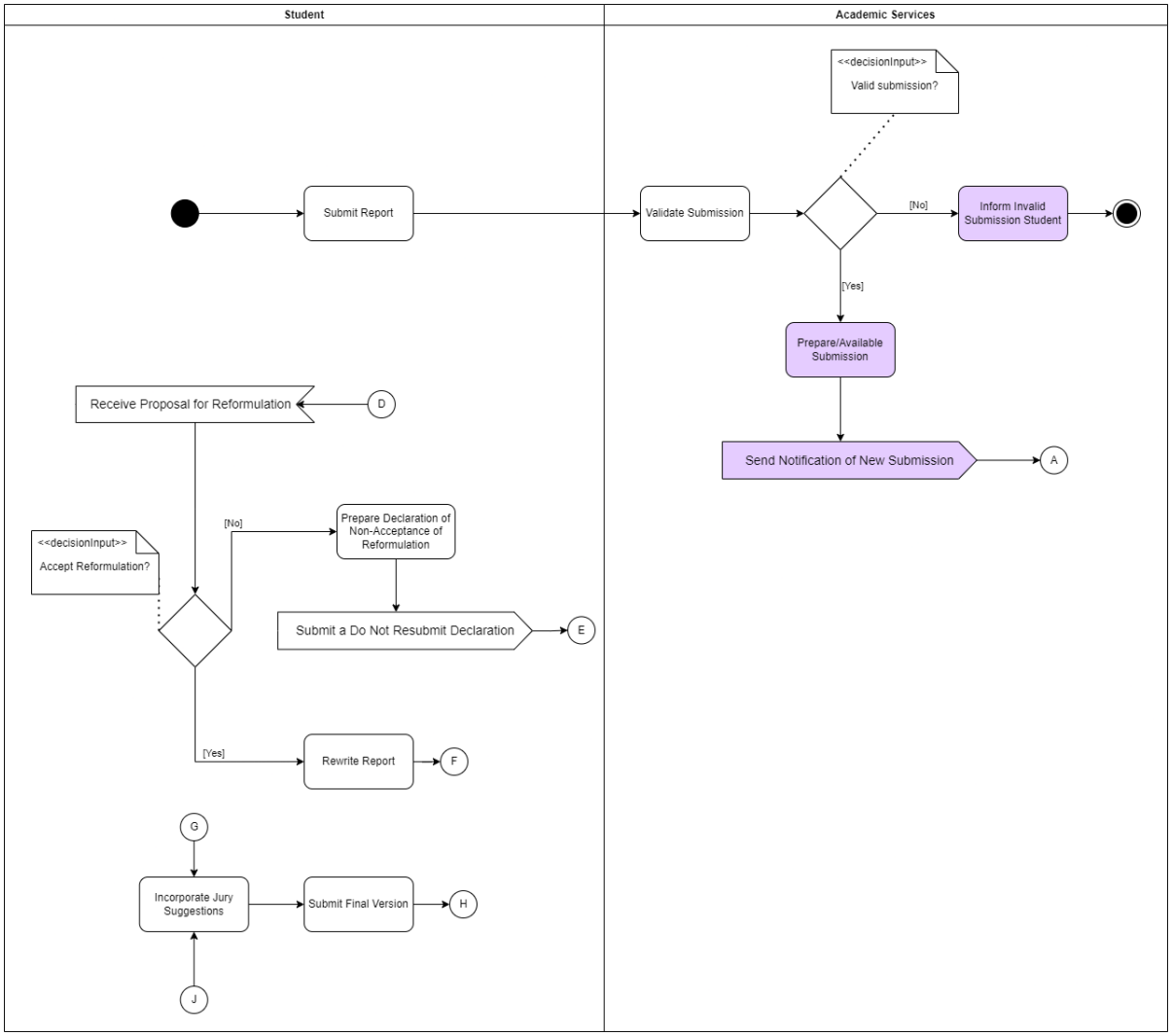


Figure 4.1: Student and Academic Services.

The proposal will then be sent to the Scientific-Technical Council, which evaluates this proposal and sends an answer to the Scientific Committee. If this proposal is accepted then those who will be part of the Jury are informed. If the proposal is not accepted then there is again the formation of a new proposal. With the Jury informed the next phase is the analysis of the report in a preliminary meeting (connector B) (figure 4.3).

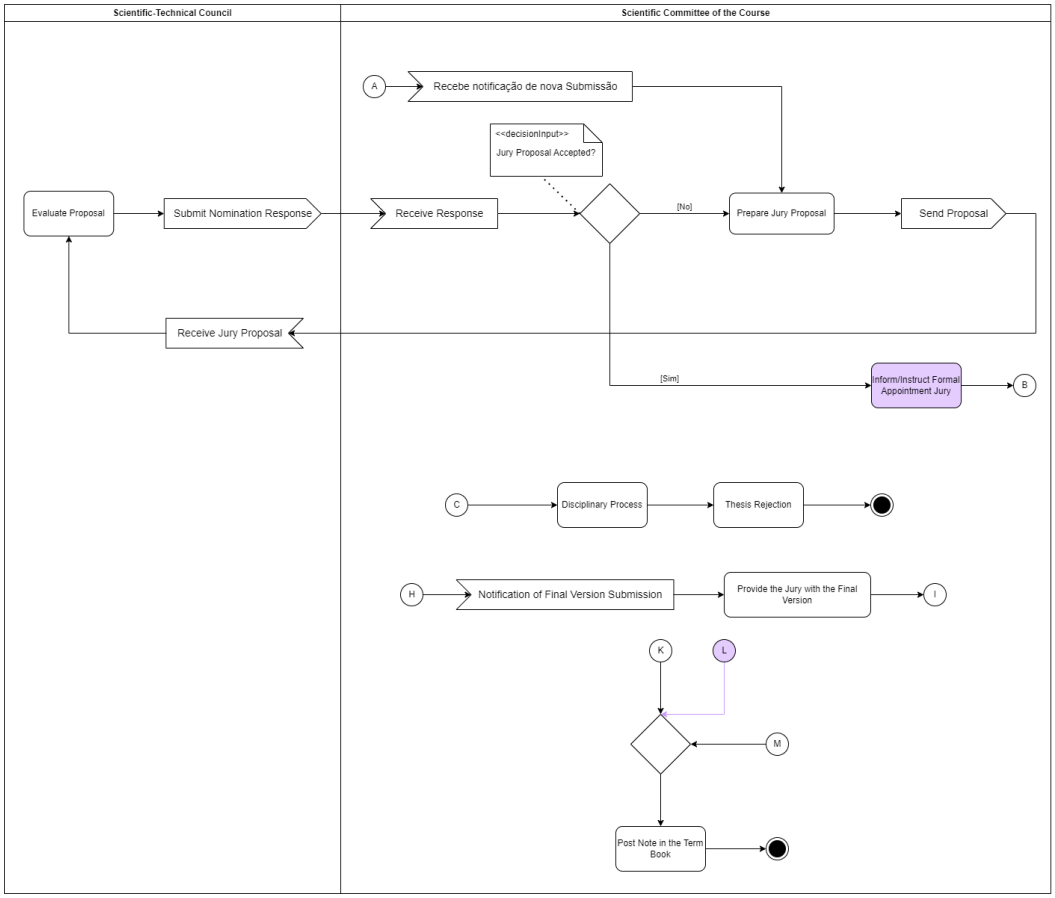


Figure 4.2: Scientific-Technical Council and Scientific Committee of the Course.

At this stage the Jury checks if improvements are necessary or if it is possible to move on to the next stage, which is the presentation, or even to check if there has been plagiarism on the part of the student. In the case of plagiarism (connector C), the student is subject to disciplinary action leading to rejection of the work. If the jury wishes the student to reformulate the report (connector D), then the jury notifies the student of this. If there is this possibility of reformulation the student may wish to reformulate and submit the report with the modifications suggested by the jury (connector F). If the student does not wish to reformulate the report then he must declare that he does not wish to do so and submit this declaration to the jury (connector E). If there is no response after 30 days of the Jury preparing the reformulation, it is considered to have been withdrawn, and the student is notified and the grade is published (connector L).

After this process, if the student has sent the declaration or the reformulation, the exams are scheduled and prepared so that the exam can be held and the minutes with the grade can be issued. Although there is the presentation, the Jury may also ask the student to add some suggestions (connector G), in order to further enrich the report. When the introduction of suggestions and the presentation of the new report are concluded and in conformity (connector H, I, J and K). If no suggestions need to be incorporated (connector M) or when their incorporation is complete, the grade is published in the book of terms.

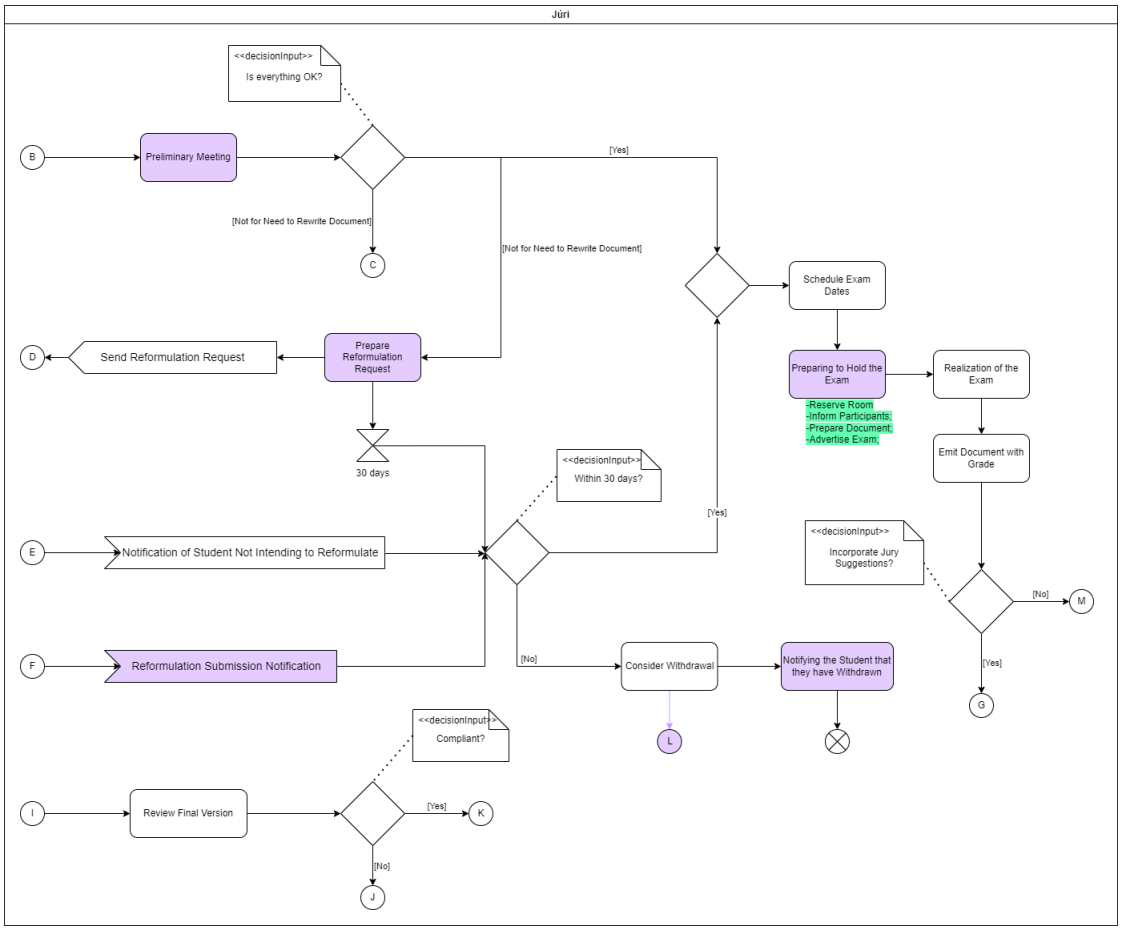


Figure 4.3: Jury.

## 4.2 BPMN Diagram

Now knowing better what happens at each stage of the submission process for a dissertation, or a project or internship report, it is possible to move to the next stage, that is, its implementation in BPMN diagram format. With that it was possible to create the following diagram to be then automated.

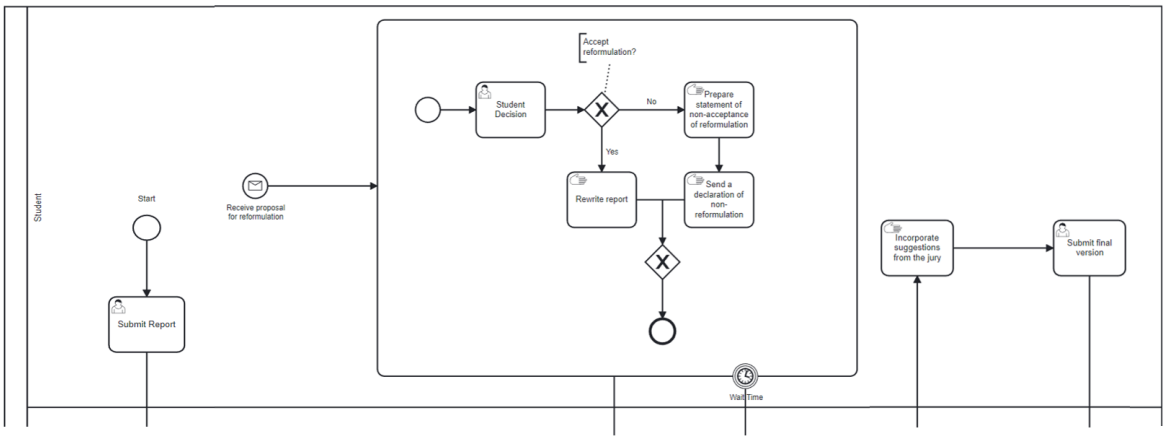


Figure 4.4: Student lane.

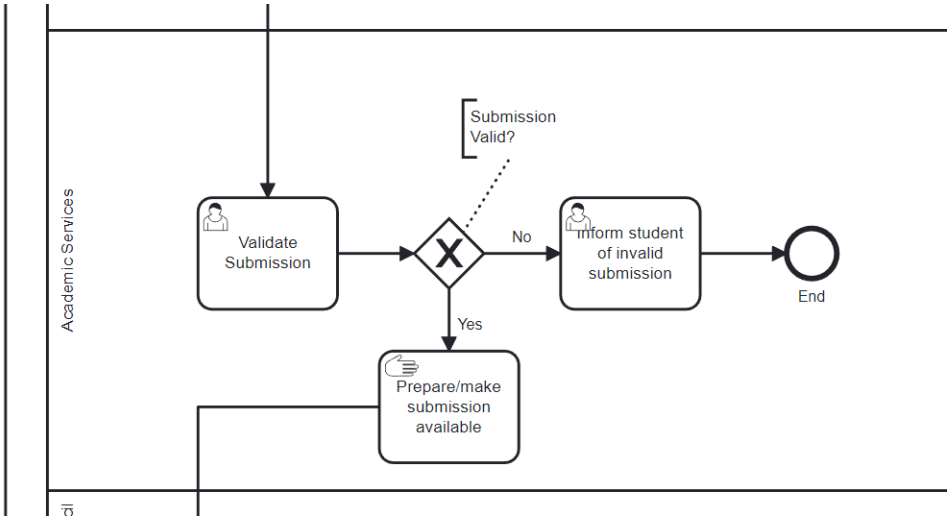


Figure 4.5: Academic Services lane.

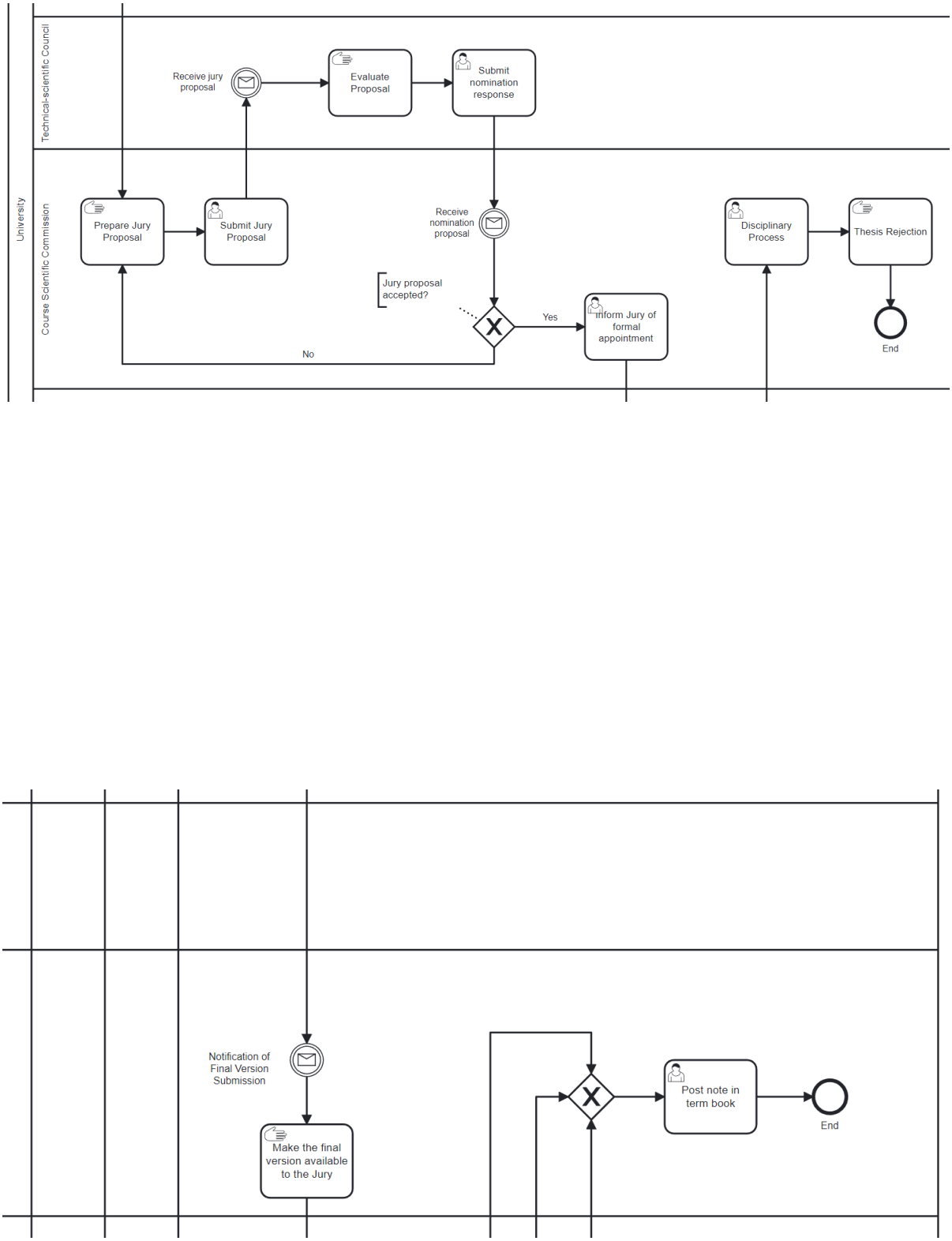


Figure 4.6: Scientific-Technical Council and Scientific Committee of the Course lanes

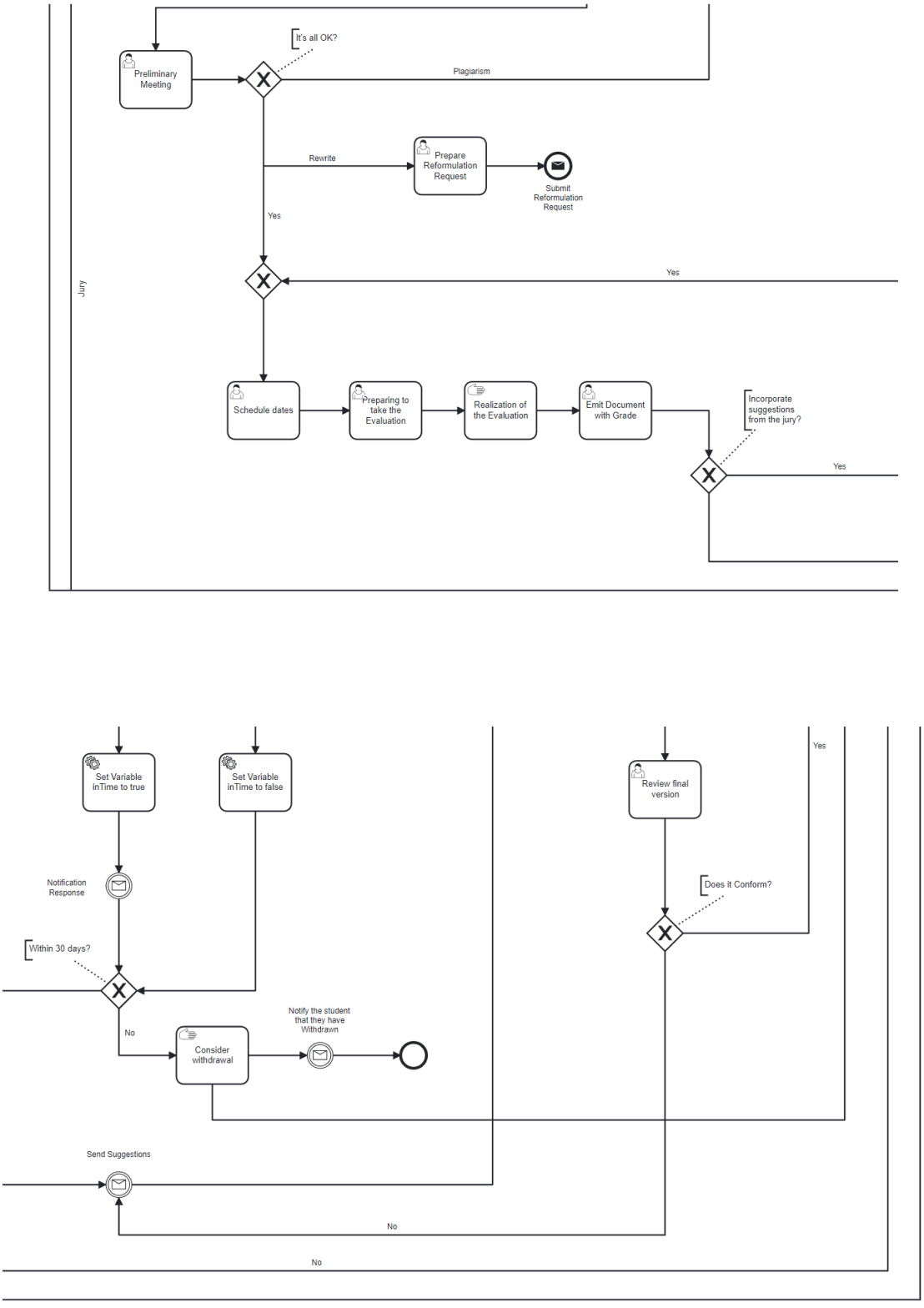


Figure 4.7: Jury lane.

## 4.3 Application on a Business Process Automation System

In order to do the implementation of this BPMN diagram it was used the tool previously selected, that is, Camunda. With this, it was necessary to make some installations and configurations so that it was possible to have a functional diagram. In addition, it was explained on how to go about the different configurations required from tasks, gateways and events used.

#### Software Installation and Configurations

To be able to use Camunda, it is necessary to have some prerequisites such as having installed the Java Runtime Environment (JRE) or a Java Development Kit (JDK) and the Apache Tomcat. With these prerequisites fulfilled it is then possible to install the Camunda Platform and Camunda Modeler [26]. Furthermore, it is required a creation of a maven project depending of type of process and configurations that are used. For that, the installation of eclipse Integrated Development Environment (IDE) is advisable [27]. For processes that require events with message sending, Postman should be installed. When all requirements are completed it is then feasible to start using the tool.

#### Pools and Lanes

The process in question is represented by a pool called University, that consists of five lanes, of which the Student, Academic Services, Technical-scientific Council, Course Scientific Commission and the Jury. To be able to run the process, it is necessary to have the Executable checkbox active (figure 4.8).

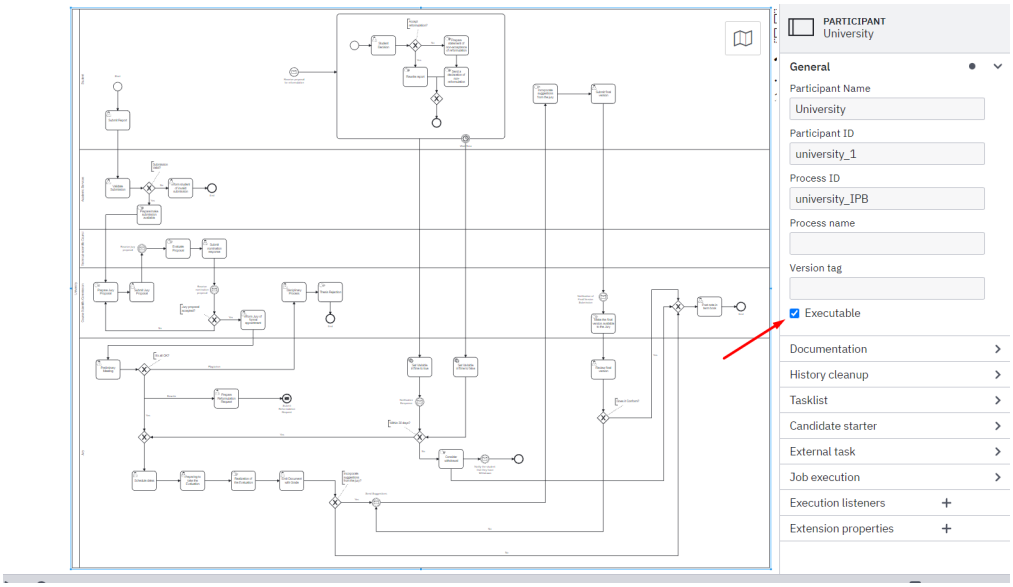


Figure 4.8: Executable process.

### Tasks Configurations

Four types of tasks were used for this process: user, manual, service and a sub process. To choose the type of task desired, it is necessary to click on the newly created task and a small menu will appear, in which one of the icons is a wrench. Clicking on this icon, another menu will appear that contains the various types of tasks that can be used (figure 4.9).

User tasks, such as the **Submit Report** task, are associated to a desired user and only that user will have access to the task to which he is assigned, leaving the process flow dependent on that same user until he completes his task. This association is made by clicking on the task and in the settings menu on the right side in the *User assignment* field write the name of the desired user. For this process the user *demo* was used (figure 4.10).

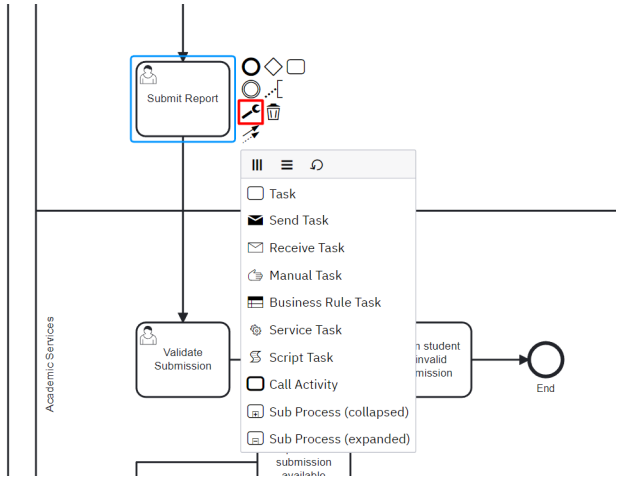


Figure 4.9: Menu with task types.

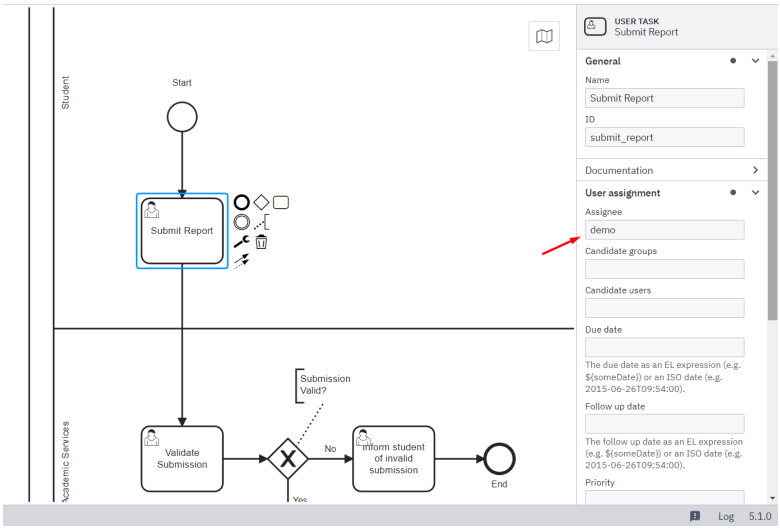


Figure 4.10: User assign in User Task **Submit Report**.

The second type of tasks used were manual tasks. Manual tasks represent a type of activity or task that is required and is external to the BPM engine. In the presented process there is the case of the **Prepare/make submission available** task (figure 4.11), which here this task is done by Academic Services but there is no knowledge of how this preparation is done and so it is a manual task.

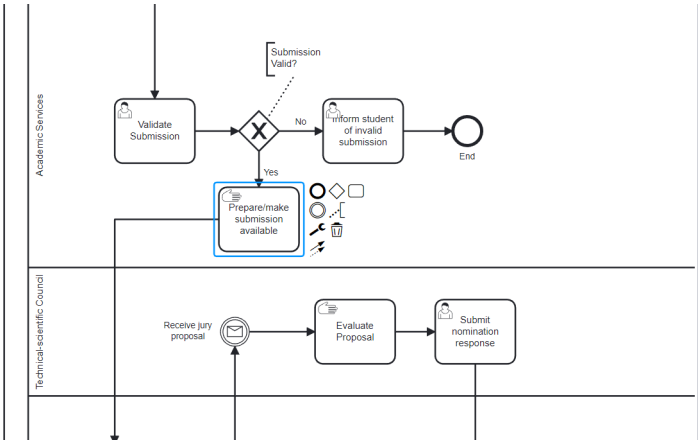


Figure 4.11: Manual Tasks.

The next type of task employed in the process were the service task, which uses an automated application or a Web service, or even other kinds of service to complete the task. In this process two service tasks were used, both of which serve to declare auxiliary variables to the process in order to ensure that it works correctly. The service tasks define the state of the variable that allows the choice of the subsequent decision path (figure 4.12).

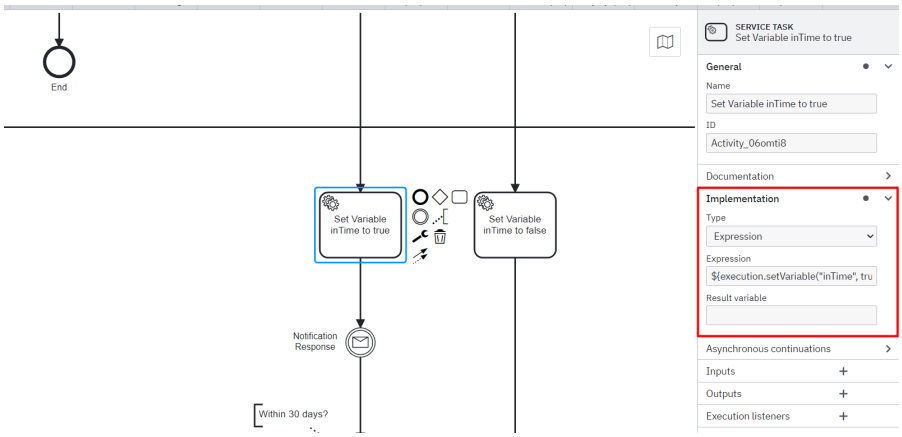


Figure 4.12: Service Tasks.

Finally, the sub process task was applied. There are two types of sub processes in Camunda, the expanded and the collapsed. For this case was used the expanded sub

process which allows the visualization of the short process to be executed directly in the diagram of the parent process. This task is to include part of the process that happens when it is necessary for the Student to rewrite the report at the request of the Jury. As it will be necessary to implement a Time Boundary Event, this extended sub process task was therefore created (figure 4.13).

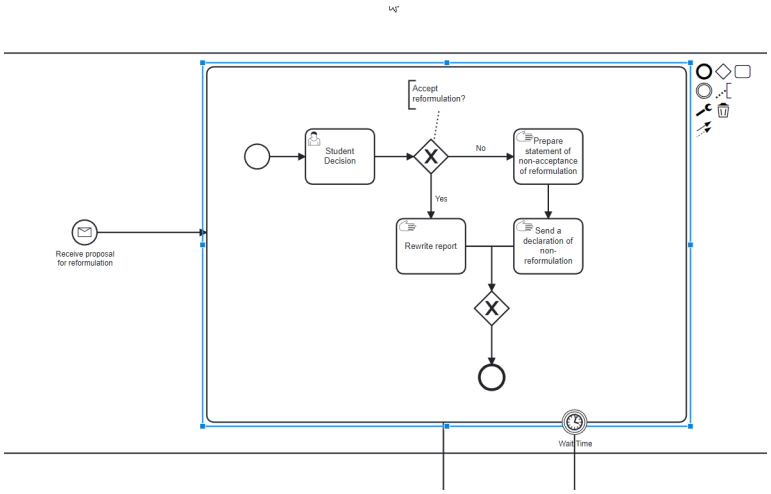


Figure 4.13: Subprocess Task.

### Creating Forms

In order for the user to perform his task of report submission, it is essential to create forms. Camunda provides this functionality by simply creating a new form file. When the form file is created, a panel is displayed on the left side that allows you to choose and drag to the middle of the screen the type of fields that are relevant to use. These fields can be of type text, number, checkbox, radio, selection, text and button.

In the following example a form with a selection field was used. Next the form was given an *Id*, which in this case will be **its_ok** (figure 4.14).

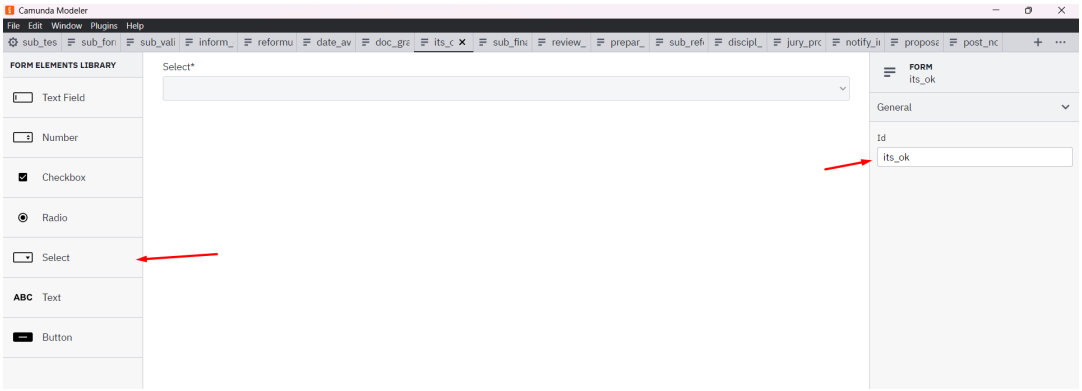


Figure 4.14: Form *Id*.

Clicking on the created selection field, the menu on the right side displays settings that can be made, such as giving the *Field label* a name, giving a *Key* (figure 4.15), adding *Values* to the selected field to display when it is to be filled in and the *Required* field (figure 4.16). The *Required* field when active ensures that the task is not completed without the added field being filled in. Save the document with the desired name, as is the case with this one called *its_ok.form*.

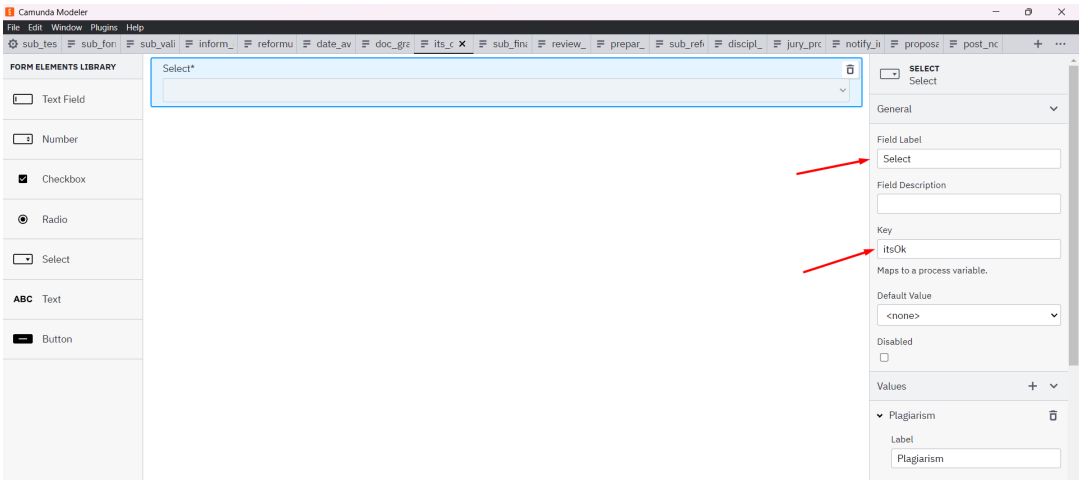


Figure 4.15: *Field label* and *Key* fields.

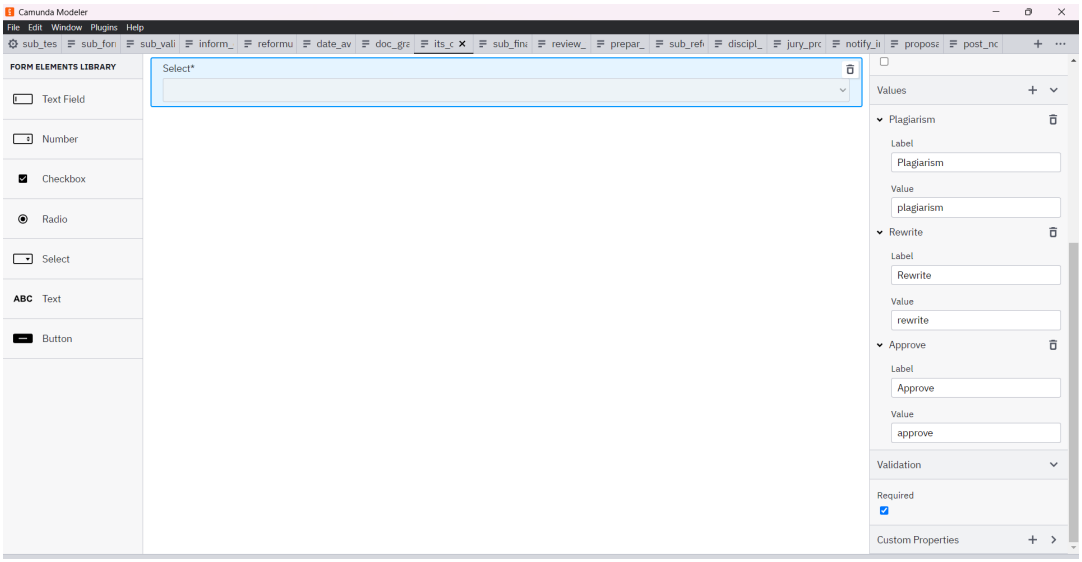


Figure 4.16: *Values* and *Required* fields filled in.

Finally, to associate the created form with the desired user task it is necessary to fill in the *Forms* field present on the right configurations menu of the user task, select the option *Camunda Forms* in the *Type* field and fill in the *Form Reference* field with the created form *Id*, which in this case will be **its_ok** (figure 4.17) [28].

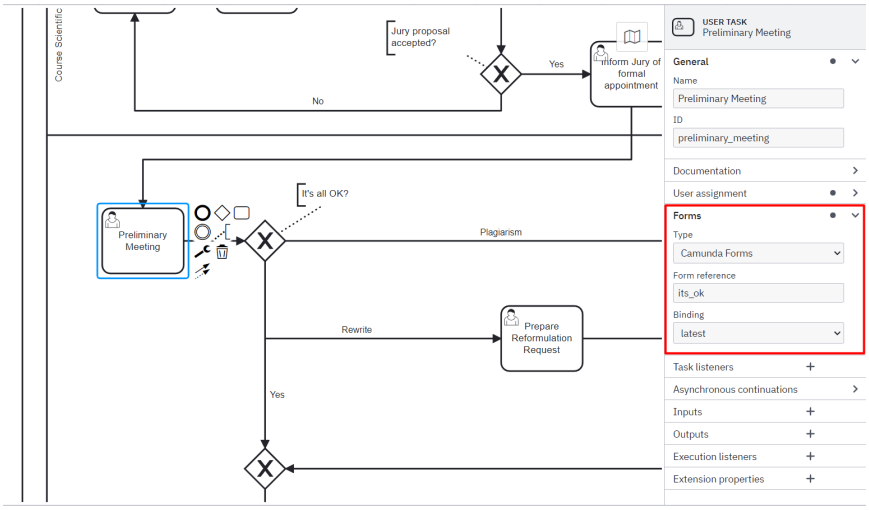


Figure 4.17: *Forms* field.

### Gateways Configurations

In order to solve some decisions present in the process flow it is fundamental to take advantage of gateways. Although there are different types of gateways, for the Report Submission process, only the exclusive gateway was used. Using a exclusive gateway to do the necessary validation it is possible to define each of the cases and then move on to a response depending on the validation done at this point. The gateway configuration is done by clicking on the connectors and defining the Condition Expression that we want to be validated present in the right menu.

For the case of the **It's all OK?** gateway the plagiarism situation, which is represented by the **Plagiarism** connector, was used the expression *#{itsOk=="plagiarism"}* (figure 4.18). The expression used is constructed with the variables from the forms created using the user tasks previously present at the gateway. For this case, the user task prior to the exclusive gateway is **Preliminary Meeting** with the *its_ok* form. Having this, the form provides the *Key* field and the *Value* fields referring to each of the selection options created, where the value filled in will be needed to construct the expression. The **Rewrite** connector becomes the expression *#{itsOk=="rewrite"}* (figure 4.19), and for the connector **Yes** the expression *#{itsOk=="approve"}* was used. (figure 4.20). [29]

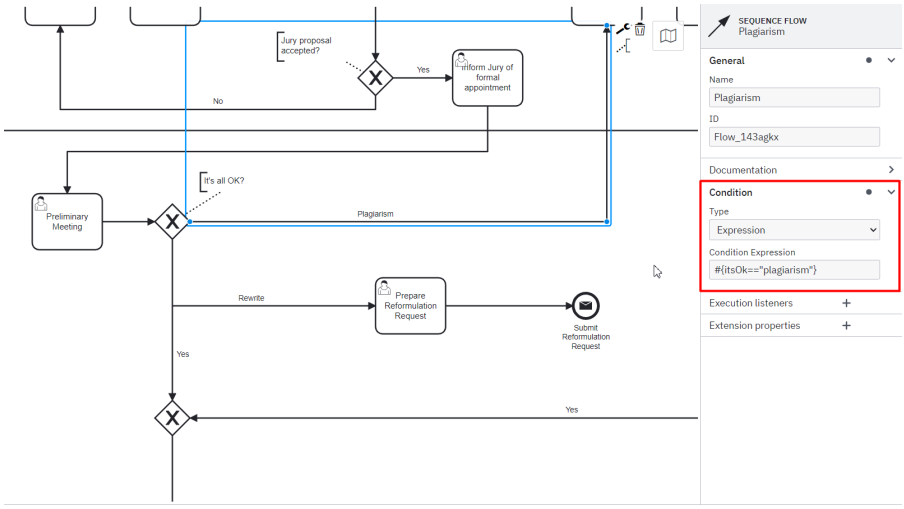


Figure 4.18: *Forms* field.

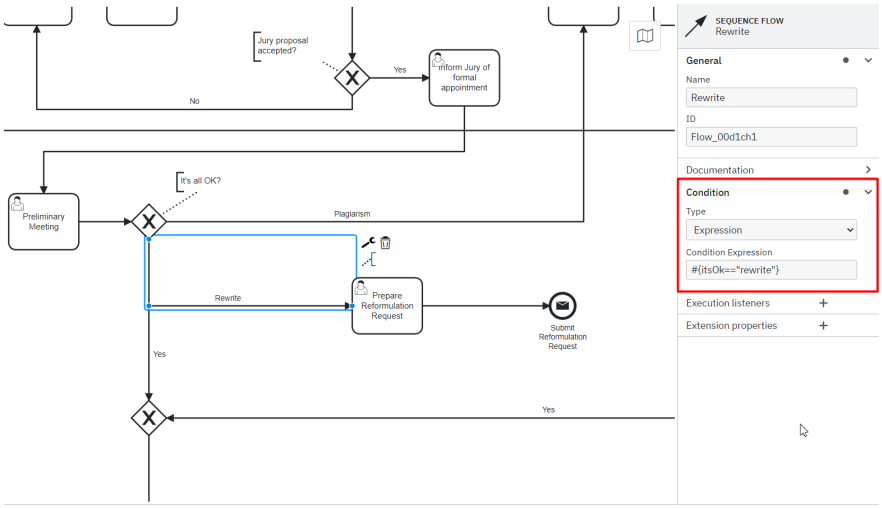


Figure 4.19: *Forms* field.

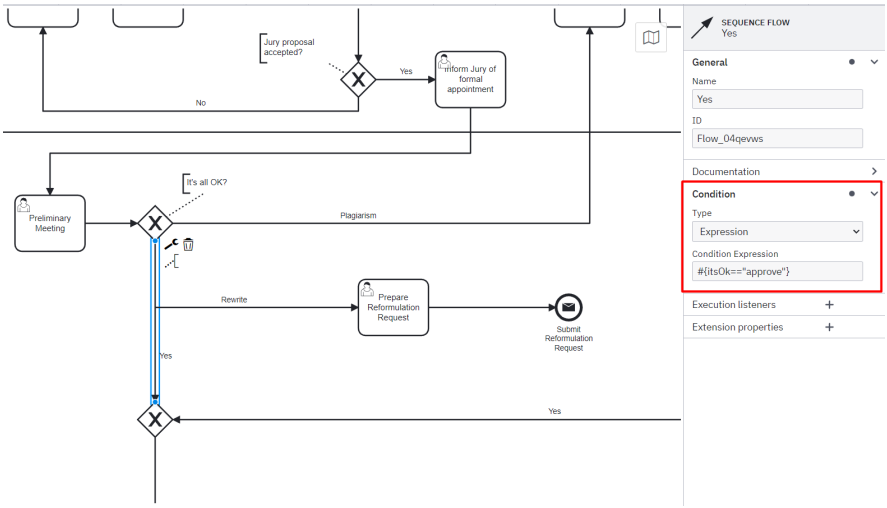


Figure 4.20: *Forms* field.

### Event Configuration

Besides there being process start and process end events, there are also moments of receiving and sending notifications, and even time counting. For the time counting event, a Timer Boundary Event linked to the Expanded Sub Process was used. This timer was configured in the *Timer* section of the menu displayed on the right side of the monitor

when the event was selected. As for this case it is desired that the event occurs with duration to represent the waiting time of 30 days, then in the *Type* field the **Duration** option is selected and in the Value field to represent the 30 days of waiting the value to be used would be **P30D**, but for this process, as it is desired to observe the verification of it occurring, the value of **PT30S** will be used for a waiting time of 30 seconds (figure 4.21). What this will do is when the token reaches the Expanded Sub Process task, this timer will start its count, and if this Sub Process task is not completed within the time imposed in the Timer Boundary Event, then the task is terminated.

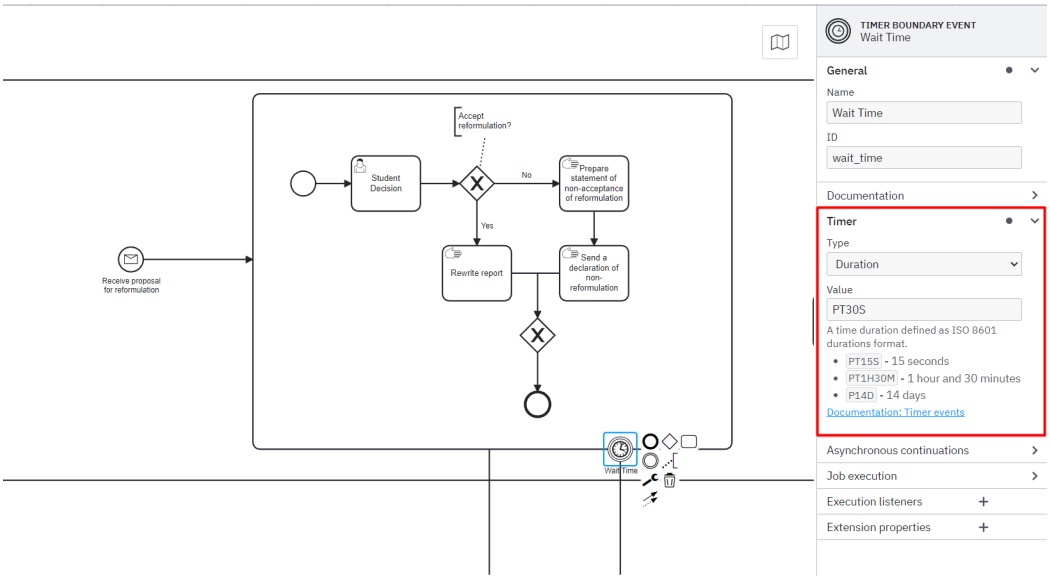


Figure 4.21: Timer Boundary Event.

The message reception events that were used in the process were the Message Intermediate Catch Event. To configure these events it is necessary to click on the desired event and fill in the *Message* field, where in the *Global message reference* the option **Create new ...** must be selected, and then give a name to the message, which in this scenario is **notify_withdrawn** (figure 4.22).

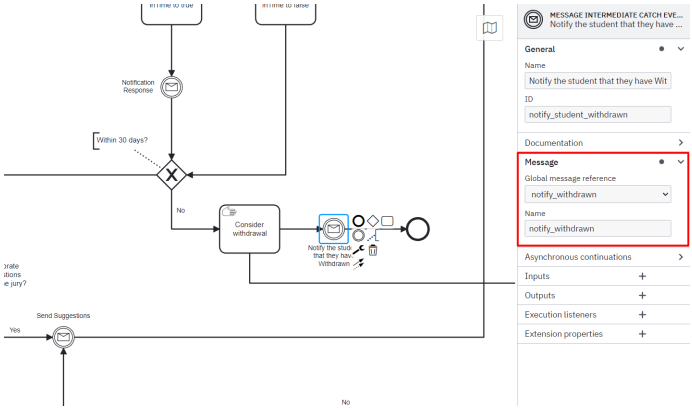


Figure 4.22: Message Intermediate Catch Event.

In the case of message sending, it was possible to make it automatic, making it advantageous for situations in which manual action is not necessary for the notification to happen. The use of message throw event allows that when the rework request submission event happens, the time event starts counting immediately. That is, the sub process is waiting to receive something, and with this throw-catch relationship, it is possible to get this automatically. In this case, the event only serves to activate this automatic sending, but it is possible to send in the throw event information that could be useful for the catch event as well as for the rest of the process [30].

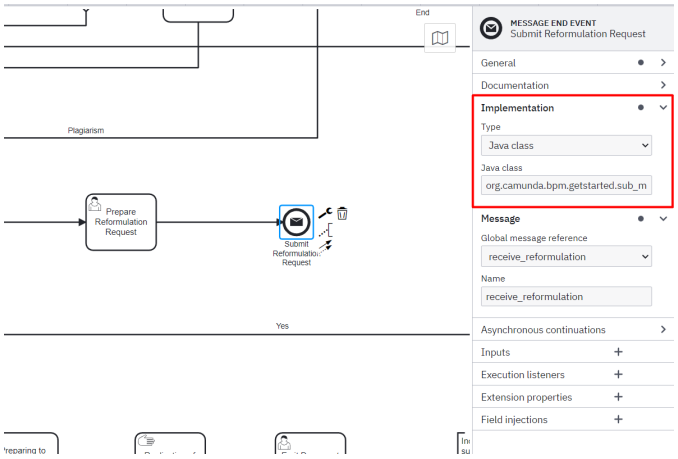


Figure 4.23: Message Throw Event.

For the message throw event to work it was necessary to create and configure a maven

project through the ecplise IDE, because it was necessary to make a java implementation to be able to use an API. To do this we followed the tutorial that Camunda provides for its configuration. It is essential to add the designed forms and the bpmn file in the resources folder and declare in the *processes.xml* file (figure 4.24). Furthermore, it is also necessary to create a class in java, in this case called **sub__messsage__classs** (figure 4.25), which allows you to trigger the sending of the message by the API.

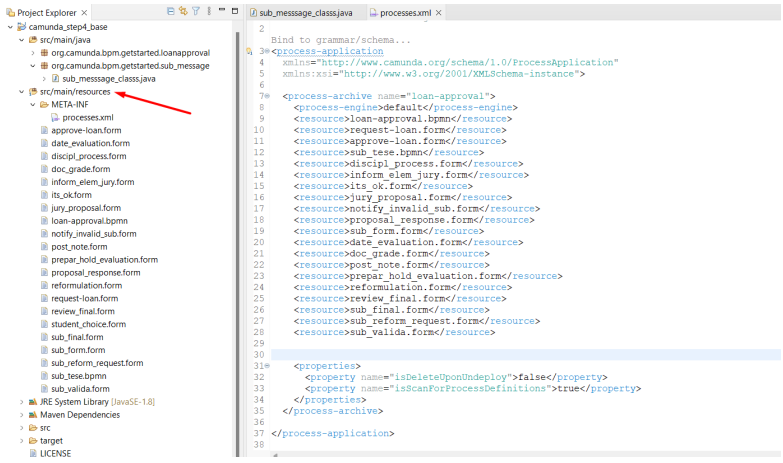


Figure 4.24: *processes.xml* file.


Figure 4.25: **sub__messsage__classs** java class.

In order for this sending to be done on the platform, the Postman tool was used, which allows a simulation of a message sending. Since it is used a REST API service to send this message, it is required to follow an specific structure that can be found on the official

documentation of Camunda about REST API [31].

Thus, whenever these message events are reached during the flow it is necessary to go to the Postman tool and create a new Request. The name given to the message, **notify_withdrawn**, is used to define in the body of the Request to identify to which event it belongs. When finished creating it just click *Send* and then the necessary information will be sent.

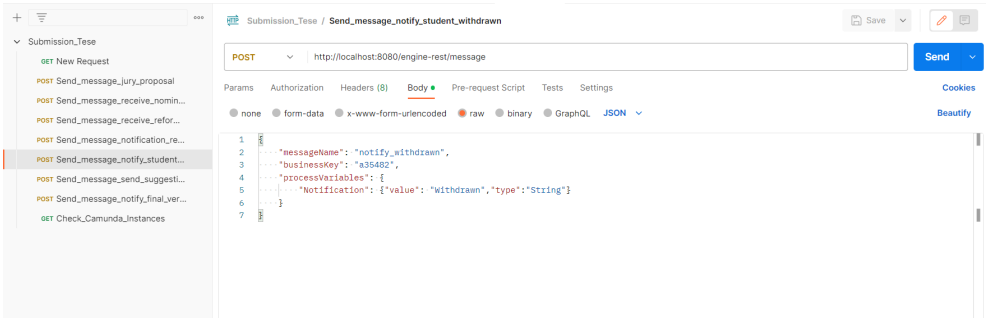


Figure 4.26: Postman message event.

### Deploy

When these configurations are ready it is then possible to deploy the project. To deploy it is necessary to perform a Maven install on the *pom.xml* file in the eclipse tool. After the build is successfully completed, the next step is to copy the file *loan-approval-0.1.0-SANPSHOT.war* that was created with the build, to the apache-tomcat's *webapps* folder and then start the file *start-camunda.bat* (figure 4.27). After apache-tomcat has finished booting it is possible to switch back to the Camunda Modeler tool by clicking on **Deploy diagram**. Before finishing the deployment it is essential to include all the forms that have been created and added to the tasks (figure 4.28).

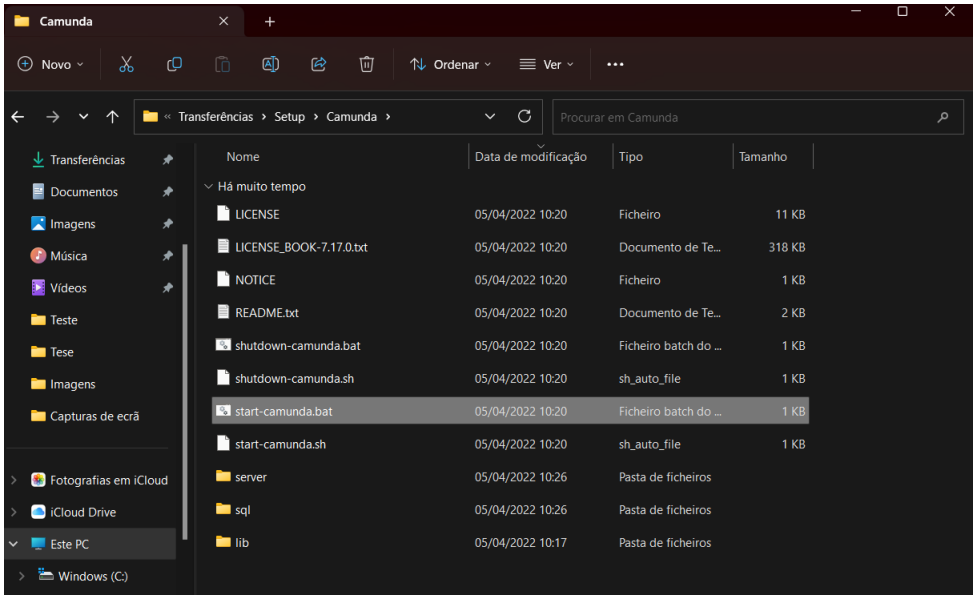


Figure 4.27: *start-camunda.bat* file.

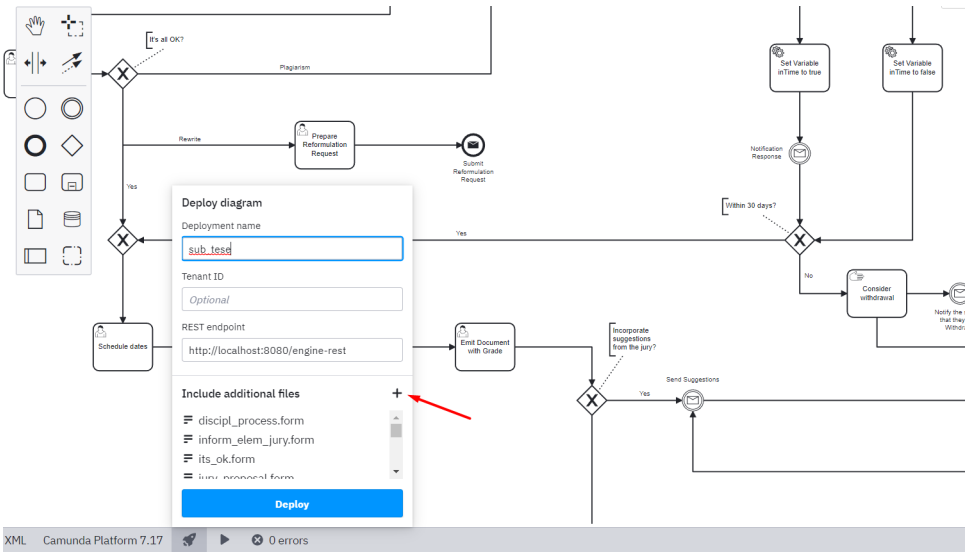


Figure 4.28: Deploy.

## 4.4 Execution on Camunda Platform

After deployment, a message will appear. By clicking on the link it will redirect to the Camunda Platform Cockpit, where a login is required (figure 4.29). By logging into the Cockpit with the *demo* user and *demo* password, you can see the forms that have been added and the process that has been developed in the Camunda Modeler, as well as explore the cockpit further and see the processes that have been initialized (figure 4.30).

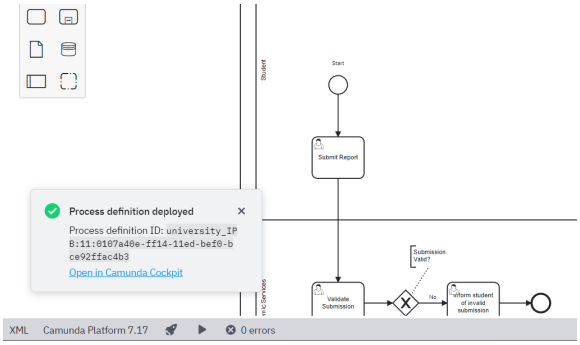


Figure 4.29: Deployment Message.

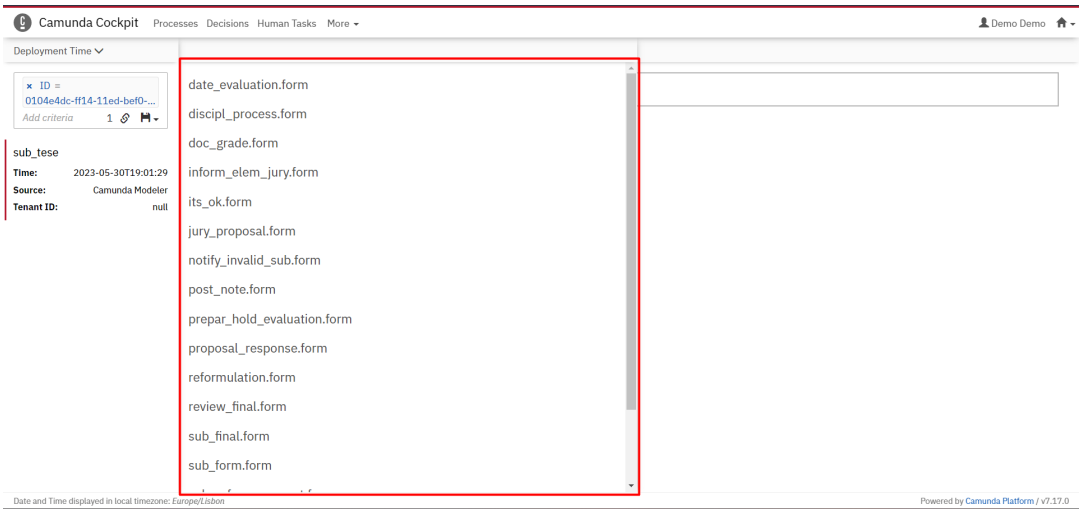


Figure 4.30: Cockpit.

To start the process the user must enter the task list and click on "*Start Process*" (figure 4.31). After clicking, a list will appear with the process, which must then be selected in

order to start it. In this case, the process to be started is the **university_IPB** process (figure 4.32). Another window will open, now to add a *Business key* and if necessary some variables. Finally, just click on "**Start**" (figure 4.33).

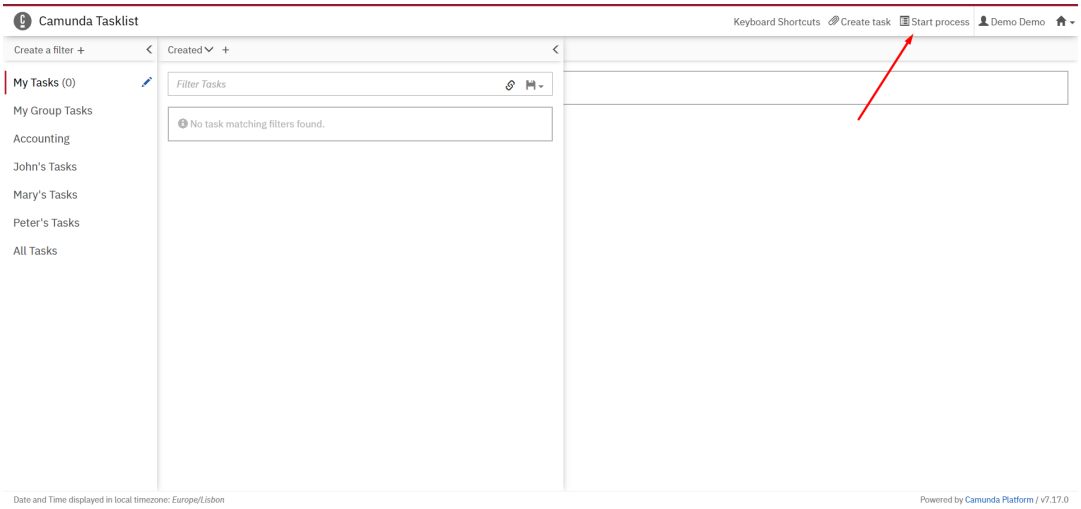


Figure 4.31: Start process.

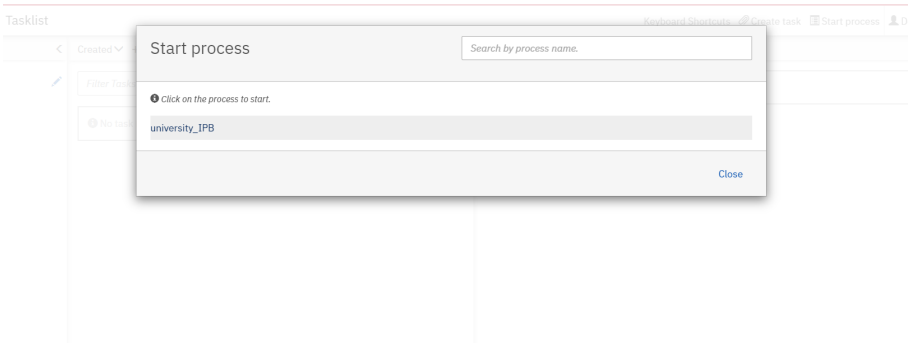


Figure 4.32: **university_IPB** Process.

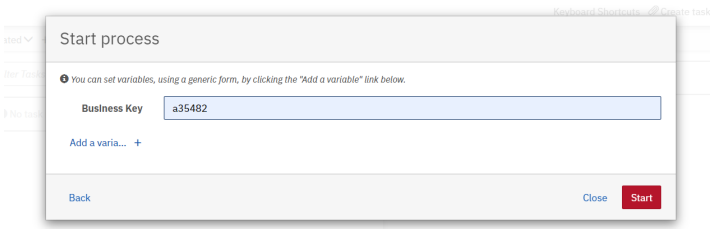


Figure 4.33: Variables to Start.

Starting the process will create a task for the Demo user in "*My Tasks*", to which the task has been assigned (figure 4.34). By selecting the task **Submit Report**, the form created for that task will appear for the user to fill in the field and complete the task. After the previous task is completed, a reload to the *My tasks* tab is necessary to be able to view the next task after the previous one is completed. In this case, the form with the checkbox for **Validate submission** will appear. Here the user can either check the checkbox or complete the task without checking it.

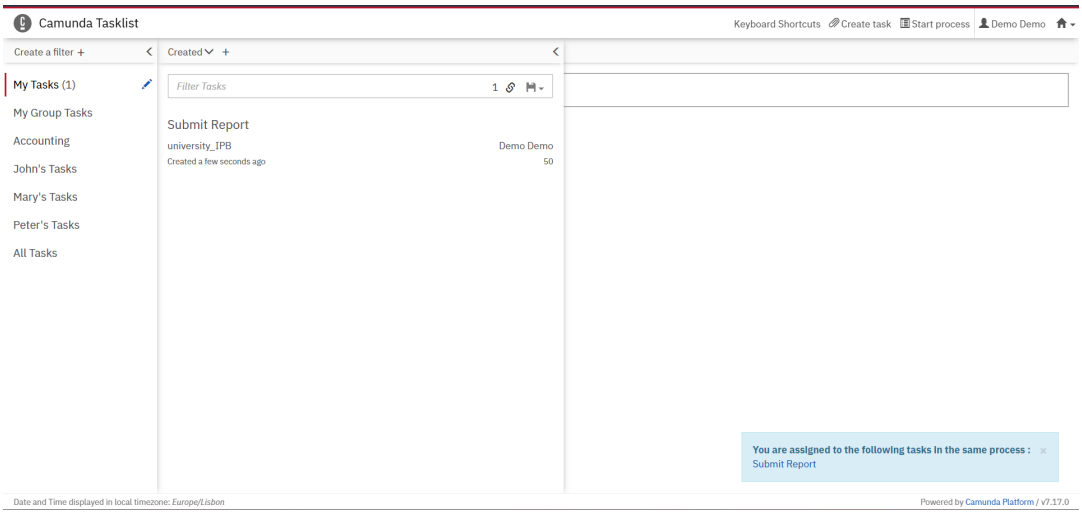


Figure 4.34: *My Tasks*.

As the flow goes on and the user completes tasks, it is possible to reach message events. When the token reaches the **Receive jury proposal** event, it is necessary to trigger the message through the Postman API, which subsequently passes on to the next task.

Arriving at the **It's all OK?** gateway, the user has the possibility to select one of three different paths (figure 4.35). If everything is in compliance, the user simply selects the "*Approve*" option and the process continues to scheduling. If there is a plagiarism detection situation, the user must choose the "*Plagiarism*" option, making the process go to the **Disciplinary Process** task and ending the whole process (figure 4.36). In case it is necessary to reformulate the report, the user should choose the "*Rewrite*" option (figure 4.37). This last option takes the *Demo* user to the next task to prepare the rewrite request and then proceed to the submission.

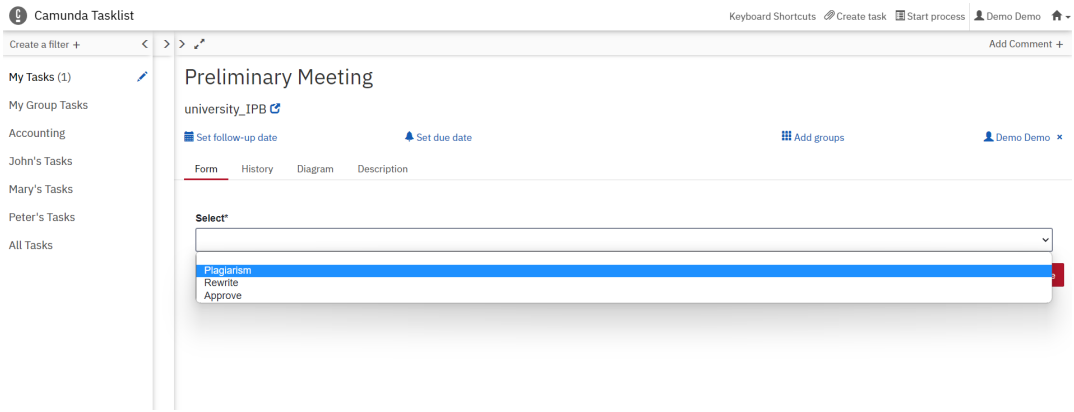


Figure 4.35: *Preliminary Meeting* Form.

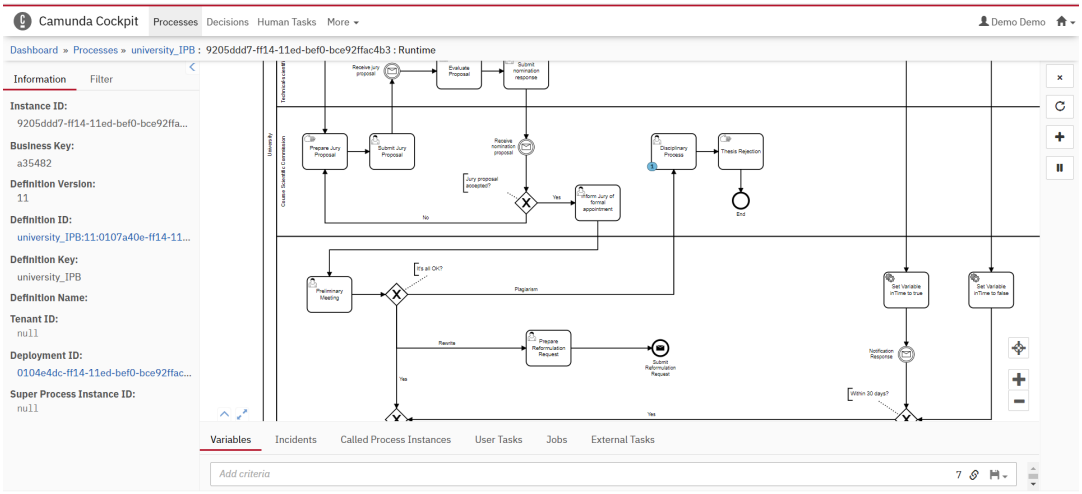


Figure 4.36: Token on *Plagiarism* path.

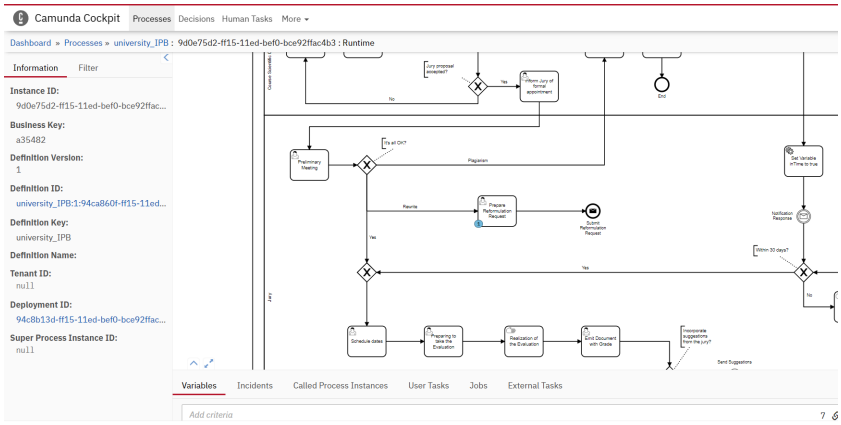


Figure 4.37: Token on *Rewrite* path.

The submission is done automatically without the need to use the Postman API. When the token reaches the **Student**, the time event starts to count, which for this case is counting down to 30 seconds (figure 4.38). If the user does not complete any task on the part of the **Student** and the time runs out, the process automatically switches to sending the notification that there was a withdrawal (figure 4.39). On the other hand, if the necessary forms are filled in within the time limit, the process moves on to **Notification Response**, so in the decision it will already take in consideration that any response coming from the student was sent on time (figure 4.40).

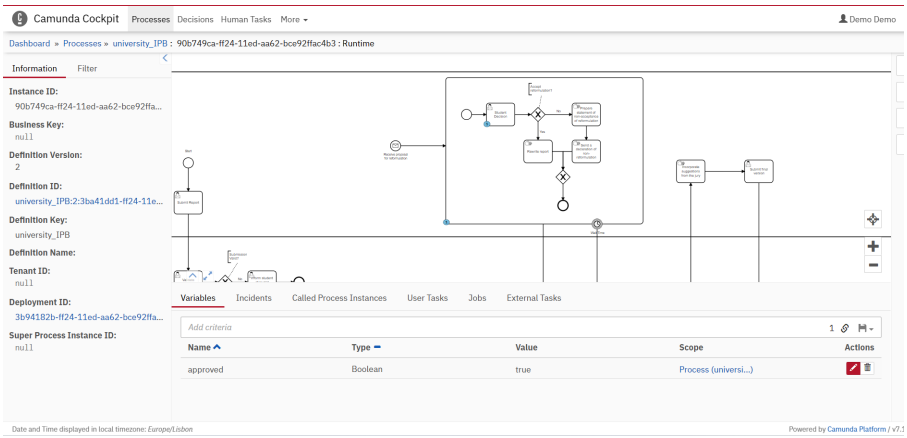


Figure 4.38: Time Event on **Student**.

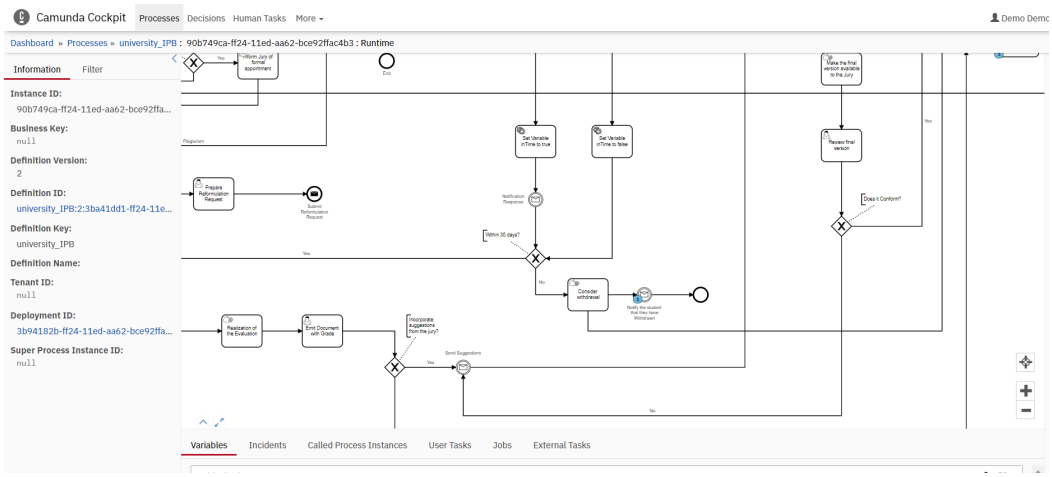


Figure 4.39: End Time Event.

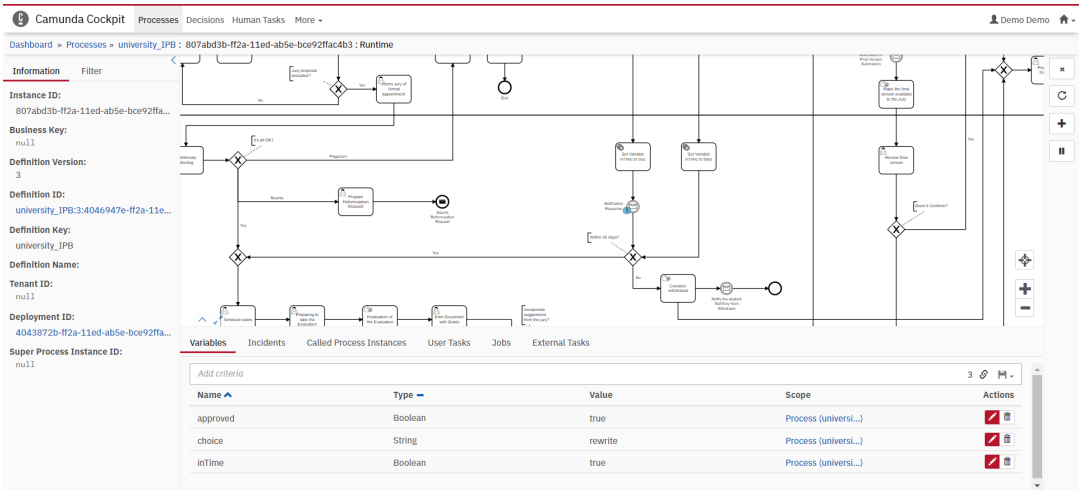


Figure 4.40: Token when Student concludes his tasks.

At the end of the execution of the entire process and the various instances, Camunda provides in its cockpit a listing of all the variables that were used and entered throughout the process (figure 4.41). This variables includes all the information sent via form or Postman, and any other variables created by the process with the purpose to assist the process automation flow.

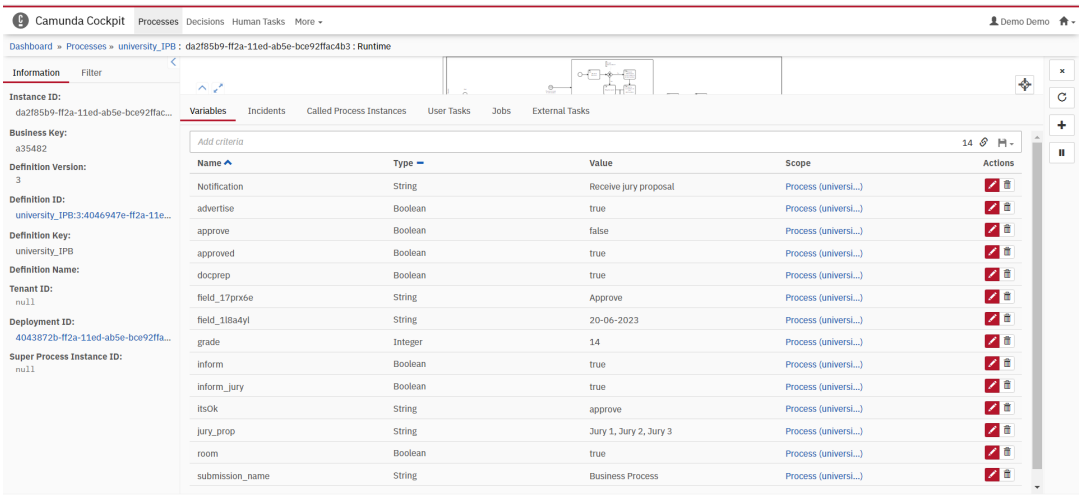


Figure 4.41: List of Variables.

# Chapter 5

# Discussion and Analysis

This chapter will discuss a first approach will be discussed, which led to the easier development of the intended work with a small example. In addition, some of the difficulties experienced during the work, as well as the solutions that were implemented.

## 5.1 First Approach

Given the complexity and amount of external systems and interactions needed for the whole process to run, it did not make sense to start developing the whole diagram immediately. This is because when the chosen process would be applied it could be necessary to apply changes to the diagram not only because of limitations that may be found in the tool itself, but also due of better solutions found during the BPMN testing phase. In order to better understand how to work with Camunda, the development of the process was started by a small example, that later it would evolve to the final one (fig 5.1). The conclusions on how to work with Camunda were already mentioned in the previous chapter, in the section Application on a Business Process Automation System.

In this case there are two pools, one representing the student and the other the academic services, and for there to be a passage from one process to the other between these two pools it is necessary to do it in the form of a message flow, as shown in the diagram bellow.

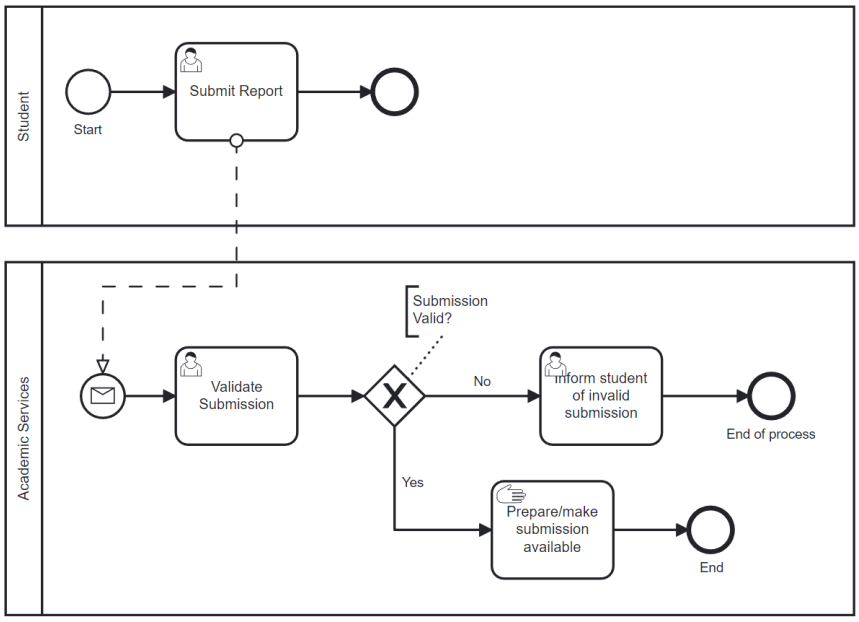


Figure 5.1: Small sample of the initial diagram.

## 5.2 Difficulties and Solutions

By doing this work it was possible to experience a technology that is increasingly handled for process automation in the business world, and to apply this tool in an academic context.

Some differences were experienced between the UML activity diagram and the BPMN diagram. One of the differences felt, was the way tasks are connected between the pools. While in the activity diagram the connections between tasks from different pools are made directly, in BPMN it is not possible. To connect tasks between pools it is necessary to place an event, for example a message, and only then make the connection. Another difference detected is the fact that in BPMN it is necessary to identify the type of task that the users are contemplating in order to identify whether it is a user task, a manual task, or even a service. This differentiation of the tasks applies properties to tell the way they should interact with the system. For example, in the case of a user task it is set up with a specific user that is associated with the lane itself. However, with UML activity

diagrams, this distinction is unnecessary.

During the maven project creation, difficulties were experienced even following the steps present in the configuration guide provided by Camunda. When following the tutorial procedure in the implementation steps, the expected was not occurring and therefore it was not possible to create the maven project correctly. To solve this problem, it was used an existing project template provided by the tutorial and configured the project according to the needs. By doing that, it was possible to make the deployment correctly [32].

There were also difficulties in creating the message events since it was necessary to implement an API. This functionality required the creation of an external communication to Camunda, which led to the creation of the maven project with a java class responsible for creating and structuring the message. This is then sent through Postman where it was necessary to configure this service in order to perform the necessary communication and send the required data for the process.

Another difficulty experienced was the issue of implementing the temporal notion within BPMN. Since it is necessary to wait a time of 30 days for the Student to decide if he wants to make any reformulation or not, it is necessary to solve it in a way that the waiting time is being counted and the action corresponding to the temporal state of the process can be automatically executed. The solution found was to create a small sub process that allows the execution of the actions assigned to the Student, and at the same time, associate with this sub process a time bound event that is accounting the time that has passed. Thus, if the Student does not complete his tasks within the stipulated time, the process is executed following the time boundary event or else, it runs through the normal path. This decision led to the creation of the service task mentioned in Chapter 4 for the creation of new variables in order to execute the right decision.

According to the development made, it is possible to perceive that the use of this type of automation tools is useful to be used in an academic context, and it can be applied in more complex process flows that exist within the institutions. This way it becomes easier to better understand the flow that exists between the various processes, such as the

renewal of enrollments, document requests, exam registrations, or even the submission of dissertation/project/internship reports, and what improvements can be made to them in order to increase efficiency and productivity in institutions.

## 5.3 Viability

Being Camunda a very intuitive system, it allowed the application of a complex process like report submission and evaluation to be done in a more agile way.

Throughout the development some difficulties were experienced in the application of events and putting them to work, so that they were triggered automatically or even simulate this automation. This in turn led to some impact on the work because it was necessary to test some solutions so that the final result was as expected.

For this specific process, there are many tasks that require the manual action of a user, such as filling in information and data. Therefore, there are few situations in which these fillings can be automated. Despite that, this automation is useful when it comes to sending this information. It also helps in streamlining the interaction of the different entities involved, and increases the robustness of checks during the process, as is the case of the 30-day time count.

## 5.4 Improvements and Future Work

One of the possible improvements could be the integration of an e-mail platform, for example Gmail or Outlook, in order to improve the interaction and ease of use of e-mail sending between the surrounding entities. With these email platforms it is possible to use services that can be integrated into an application, and that can allow to send messages automatically, that do not require human action.

A possible future work would be to apply a process flow in the different systems presented and compare the differences and difficulties experienced, as well as the advantages in user experience. It may also be relevant to apply other examples of process flows that

exist in the academic context, such as those mentioned above, for example the enrollment of new students.

# Chapter 6

# Conclusions

With this project, it was possible to obtain a vast knowledge in relation to the areas of BPM and automation. Not only it allowed to better understand the structuring and construction of this kind of processes, but also helped to understand how to integrate these processes with automation. And so, realize the potential of using an automation system to take advantage of automated processes.

One of the main objectives of this work was to verify the viability of automating some processes in the academic context. Although the development done during the work has originated a simple example without great application complexity, it managed to show some of the advantages that the implementation of automation can bring to these processes.

Despite the fact that this entire system was not automated, either by situations that require manual action or by situations in which more development is needed in order to make it a fully automated process, this work served as a simulation of how an automated process would work, and verify whether or not this system was in fact feasible to automate. Therefore, it is concluded that it is possible and advantageous to apply this automation and that there is room for improvement of these processes.

During the implementation of the BPMN diagram in the tool, some difficulties were also experienced in its implementation. These difficulties come from the fact of being a different platform, where the development requires some knowledge in business process

and it is necessary to learn how these diagrams are used to develop automation. Therefore, the initial learning curve for this tool is higher.

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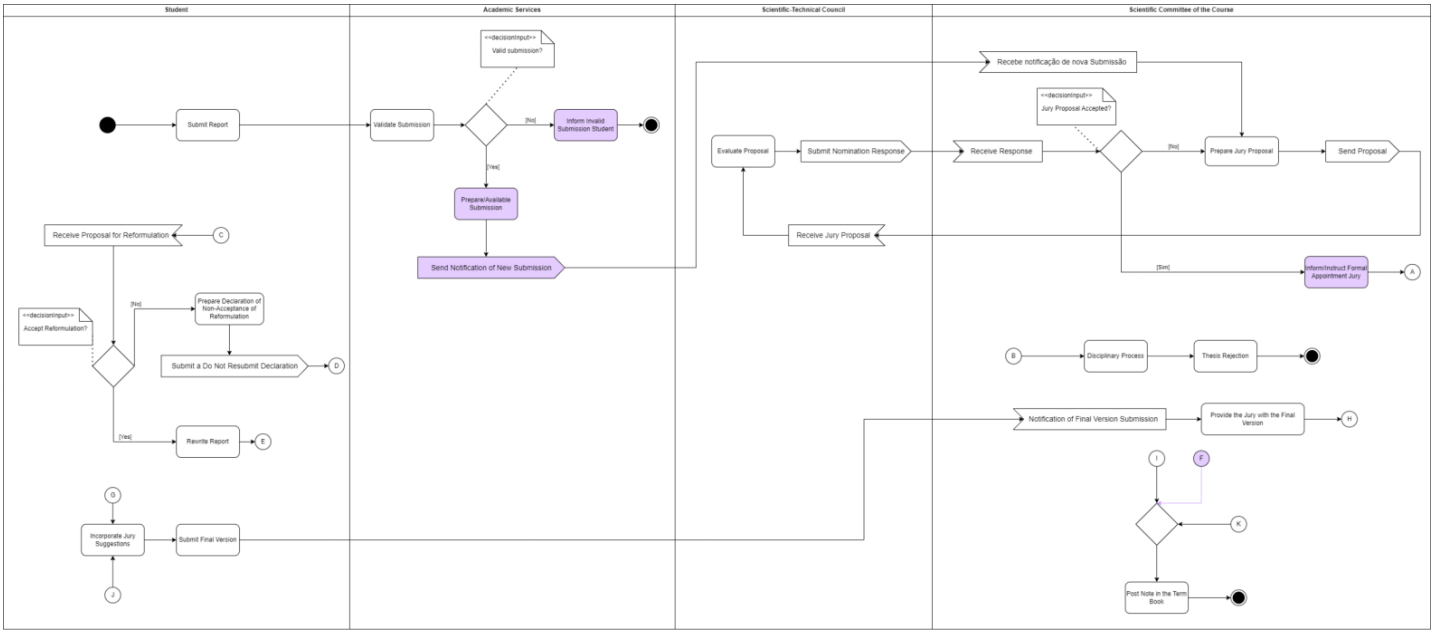
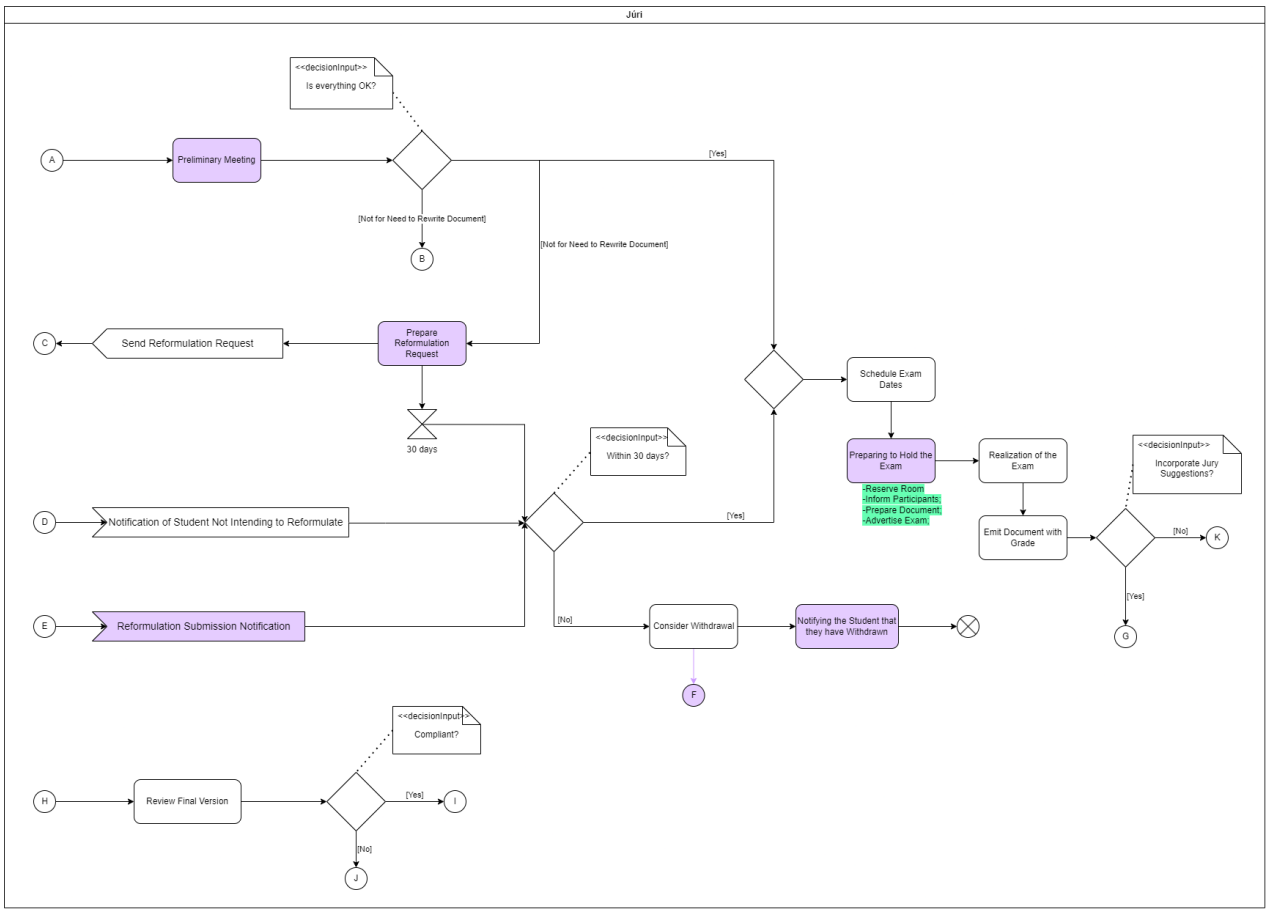
# Appendix A

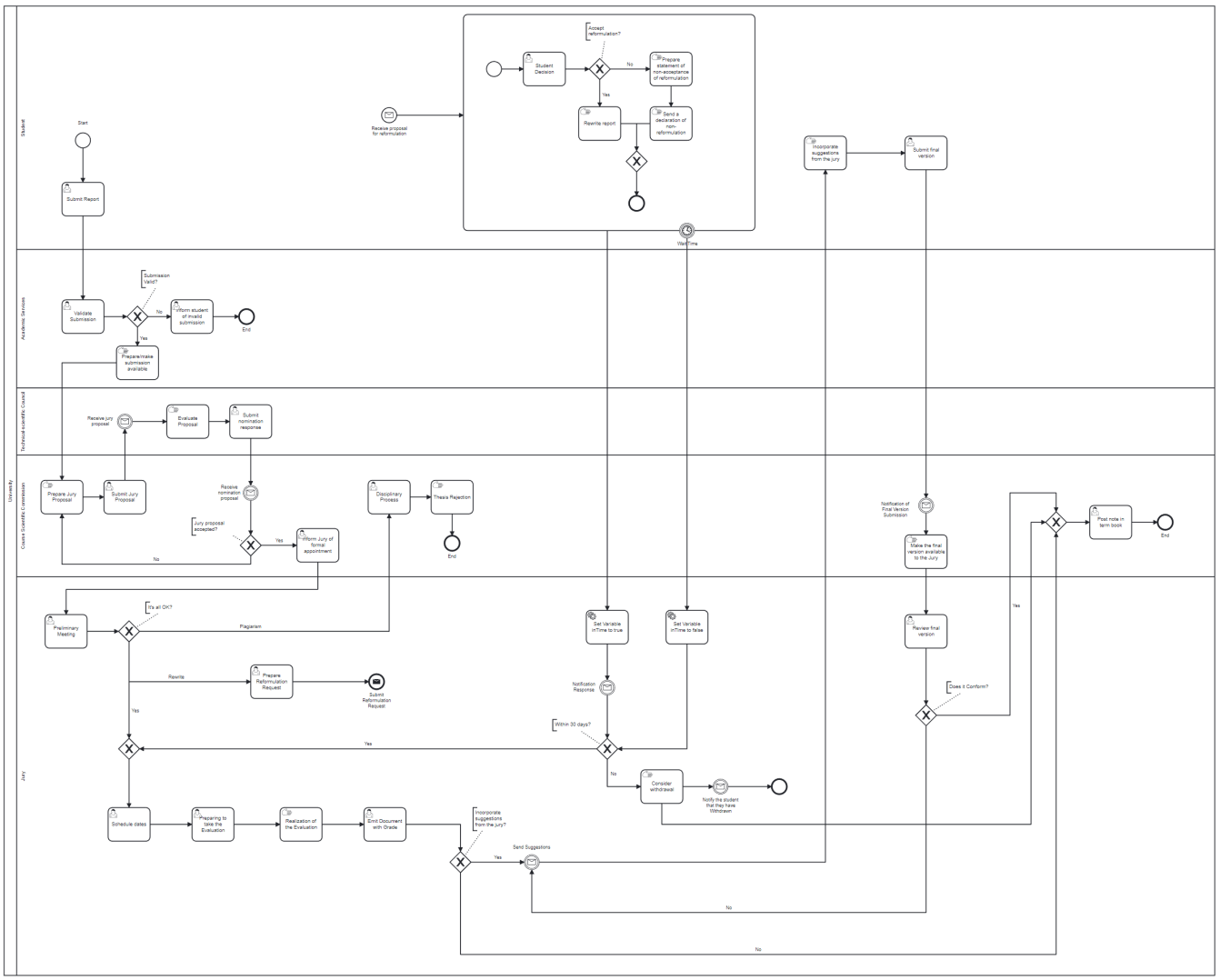
# Activity Diagram


Student
Academic Services
Scientific-Technical Council
Scientific Committee of the Course
Submit Report
Validate Submission
<<decisionInput>> Valid submission?
[No]
Inform Invalid Submission Student
[Yes]
Prepare/Available Submission
Send Notification of New Submission
Recebe notificação de nova Submissão
<<decisionInput>> Jury Proposal Accepted?
Evaluate Proposal
Submit Nomination Response
Receive Response
[No]
Prepare Jury Proposal
Send Proposal
Receive Jury Proposal
[Sim]
Inform/Instruct Formal Appointment Jury
A
Receive Proposal for Reformulation
C
<<decisionInput>> Accept Reformulation?
[No]
Prepare Declaration of Non-Acceptance of Reformulation
Submit a Do Not Resubmit Declaration
D
[Yes]
Rewrite Report
E
B
Disciplinary Process
Thesis Rejection
Notification of Final Version Submission
Provide the Jury with the Final Version
H
I
F
K
Post Note in the Term Book
G
Incorporate Jury Suggestions
Submit Final Version
J


Júri
<<decisionInput>> Is everything OK?
A
Preliminary Meeting
[Yes]
[Not for Need to Rewrite Document]
B
[Not for Need to Rewrite Document]
C
Send Reformulation Request
Prepare Reformulation Request
30 days
<<decisionInput>> Within 30 days?
Schedule Exam Dates
Preparing to Hold the Exam
-Reserve Room
-Inform Participants
-Prepare Document
-Advertise Exam
Realization of the Exam
Emit Document with Grade
<<decisionInput>> Incorporate Jury Suggestions?
[No]
K
[Yes]
G
D
Notification of Student Not Intending to Reformulate
[Yes]
E
Reformulation Submission Notification
[No]
Consider Withdrawal
Notifying the Student that they have Withdrawn
F
<<decisionInput>> Compliant?
H
Review Final Version
[Yes]
I
[No]
J

# Appendix B

# BPMN Diagram


University
Student
Academic Division
Technical-scientific Council
Course Scientific Commission
Jury
Start
Submit Report
Validate Submission
Submission Valid?
No
Yes
Inform student of invalid submission
End
Prepare/make submission available
Receive jury proposal
Evaluate Proposal
Submit nomination response
Prepare Jury Proposal
Submit Jury Proposal
Receive nomination proposal
Jury proposal accepted?
Yes
No
Inform Jury of formal appointment
Disciplinary Process
Thesis Rejection
End
Preliminary Meeting
It's all OK?
Plagiarism
Rewrite
Prepare Reformulation Request
Submit Reformulation Request
Yes
Schedule dates
Preparing to take the Evaluation
Realization of the Evaluation
Emit Document with Grade
Incorporate suggestions from the jury?
Yes
Send Suggestions
No
No
Receive proposal for reformulation
Student Decision
Accept reformulation?
No
Prepare statement of non-acceptance of reformulation
Yes
Rewrite report
Send a declaration of non-reformulation
Wait Time
Set Variable inTime to true
Set Variable inTime to false
Notification Response
Within 30 days?
Yes
No
Consider withdrawal
Notify the student that they have Withdrawn
Incorporate suggestions from the jury
Submit final version
Notification of Final Version Submission
Make the final version available to the Jury
Review final version
Does it Conform?
No
Yes
Post note in term book
End

B2