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Ministry of higher Education and Scientific Research
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Faculty of Exact Sciences, Science of Nature and Life
Computer Science Department

Order N°: GLSD/M2/2023

Thesis

Presented to obtain the academic master's degree in

Computer science

Option : (GLSD)

Rapid Development of Platform Using BPMN : Administrative Platforms.

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Session 2022-2023

Acknowledgements

First and foremost, we would like to express our heartfelt gratitude to Almighty God for granting us the opportunity and guidance to achieve our goals and succeed in this part of our life's journey so far.

We would also like to extend our deepest thanks to our parents for their love and unwavering support, especially during the last three months of our graduate studies. Without them, this day would not have been possible.

We are also deeply thankful to our esteemed professors, Professor **Kahaloul Laid**, Dr. **Ramdani Mohamed**, and Dr. **Bettira Roufaida**, for their valuable insights, knowledge, and dedication to our success.

We would also like to thank the members of the thesis committee for their time and effort in reviewing our work.

We are also extending special thanks to the members of the lab. Best of luck to all of you. Moreover, we would like to extend our appreciation to our families, friends, and everyone who has supported us throughout our academic journey. Without their encouragement and assistance, we would not have been able to accomplish this achievement.

May God bless you all.

Ferhati Mouna Salsabil

Lassel Hadjer

Abstract

Business Process Management is a systematic approach that aims to enhance the efficiency and effectiveness of an organization's processes. This study showcases the design and implementation of a workflow application tailored for a scientific research laboratory at the Faculty of Computer Science, University of Biskra. The application is developed using the standard Business Process Model and Notation 2 (BPMN2) and implemented on the Bonita Soft platform. The main objective of this project is to enhance the efficiency and effectiveness of the laboratory's processes by providing a structured method for managing workflows. The project outlines the key processes within the laboratory and utilizes BPMN2 to model the workflows. The Bonita Soft platform is employed for implementing and testing the workflows. The study concludes by presenting the interfaces of the application and offering recommendations for future research in this field.

Keywords: BPM, BPMN, Bonita, automation, and process.

Résumé

La gestion des processus métier fait référence à une approche systématique qui vise à améliorer l'efficacité et l'efficience des processus d'une organisation. Ce travail présente la conception et la mise en œuvre d'une application de flux de travail pour un laboratoire de recherche scientifique à la Faculté d'informatique de l'Université de Biskra. L'application est conçue selon la norme Business Process Model and Notation 2 (BPMN2) et mise en œuvre sur la plateforme Bonita Soft. L'objectif de ce travail est d'améliorer l'efficacité et l'efficience des processus du laboratoire en fournissant une approche structurée pour la gestion des flux de travail et en favorisant la collaboration entre les parties prenantes. Ce projet présente les principaux processus impliqués dans le laboratoire et utilise BPMN2 pour modéliser les flux de travail. La plateforme Bonita Soft est utilisée pour mettre en œuvre et tester les flux de travail. Nous concluons notre travail en présentant certaines interfaces de notre application, ainsi que des recommandations pour des recherches futures dans ce domaine.

Mots-clés: BPM, BPMN, Bonita, automatisation et processus.

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Chapter 1

General Introduction

Software engineering is a discipline that has significantly transformed the development of modern computing. It encompasses principles, methods, and tools necessary for the creation, maintenance, and evolution of software. Through the application of software engineering practices, developers can design efficient, reliable, and scalable programs that cater to the growing needs of society. This field has streamlined development processes, improved software quality, and reduced production costs, leading to advancements in various technological domains. One such domain that has benefited greatly from software engineering is Business Process Management (BPM). BPM involves the systematic management of business processes to improve efficiency, agility, and overall performance within an organization. By applying software engineering principles, developers can design and implement BPM solutions that automate and optimize complex workflows, enabling businesses to achieve better control, visibility, and productivity. In the realm of BPM, the BPMN (Business Process Model and Notation) standard plays a crucial role. BPMN provides a graphical modeling language for representing business processes in a clear and standardized manner. It utilizes intuitive symbols and notation, enabling effective communication and collaboration between business teams and developers. With BPMN, stakeholders can gain a shared understanding of processes, facilitating the design, analysis, and improvement of workflows.

Within the context of our project, we will focus on the Bonita platform, an open-source BPM solution. Bonita offers a powerful and flexible environment for the design, development, and deployment of business applications. Its process-centric approach simplifies the modeling and automation of workflows, providing organizations with better visibility and precise control over

their operations.

The specific objective of our project is to develop a workflow application for a laboratory using the Bonita platform. Laboratories require efficient management of complex processes. By leveraging the capabilities of Bonita, we aim to streamline and automate these processes. Through this project, we will explore the potential of software engineering principles and the Bonita platform in addressing the unique challenges faced by laboratories. By developing a tailored workflow application, we aim to improve the efficiency of processes, reduce manual errors, enhance data integrity, and ultimately contribute to the overall effectiveness of the laboratory's operations.

In the following chapters, we will delve into the theoretical foundations of software engineering, BPM, and the BPMN standard. We will then present a detailed analysis of the Bonita platform, examining its features, capabilities, and suitability for our project. Finally, we will discuss the methodology and implementation of our workflow application, documenting the design decisions, challenges encountered, and the achieved outcomes.

Problematic

Laboratories play a crucial role in scientific research and various industries, but their operations often involve complex and time-consuming tasks that require meticulous organization and management. Traditional approaches to managing laboratory workflows rely heavily on manual processes, leading to inefficiencies, errors, and delays in research and development activities. To address these challenges, the implementation of a management application for the laboratory using the BPMN (Business Process Model and Notation) standard and the Bonita platform offers a promising solution. However, several key problems need to be addressed to ensure the successful implementation and adoption of such an application.

Research Questions:

1. What are the primary challenges and bottlenecks faced in managing laboratory tasks and workflows using traditional manual methods?
2. How can the BPMN standard be leveraged to model and optimize laboratory workflows

for improved efficiency and accuracy?

3. What are the key features and functionalities that should be included in a laboratory management application to streamline task organization and automation?
4. How can the Bonita platform be utilized to implement the proposed laboratory management application effectively?
5. What are the potential benefits and limitations associated with the adoption of a laboratory management application based on BPMN and the Bonita platform?

Objective of the work

This work presents the design and implementation of a workflow application that ensures a smooth and effective management of laboratory processes at the Faculty of Computer Science, University of Biskra. It is therefore a question of designing and implementing a solution allowing to:

- Gather information on the current processes in the lab to know the weaknesses and deficiencies in relation to these processes.
- Analyze the current processes.
- Design of existing processes to improve Workflow application efficiency.
- Draw processes model by BPMN2 on the Bonita tool serves for the automation of the process.
- Build an application that automates the lab processes.

This report is organized into four chapters:

- **Chapter 2: Workflow Approach** This chapter contains general definitions of the domain, such as groupware, workflows, and types of applications. Moreover, it provides information about workflow applications.
- **Chapter 3: Processes and Modeling:** This chapter is about theoretical techniques and tools used for the process of modeling and developing our application.

- **Chapter 4: Analysis and design:** This chapter contains the project's analysis and design as well as the different proposed diagrams.
- **Chapter 5: Implementation and Results:** The final one shows our implementation steps and our developed application.

Chapter 2

Workflow Approach

Introduction

A company's productivity and competitiveness are greatly influenced by the work process is organized and distributed. The automation and the facilitation of concurrent tasks inside a corporation, groupware technology, such as Workflow, may enhance work processes and expedite information flows. To optimize group work and achieve the desired performance, businesses have recently turned to process-based work structures as a possible alternative to the traditional hierarchical organization. Workflows were first used in businesses to automate administrative processes including papers transfer between departments. They subsequently had significant success simulating industrial processes in the area of software engineering.

In this chapter, we will see the workflow, and explain the typology of workflows and their main fundamental elements. Finally, we will conclude by presenting the types of existing workflows and the most recent reference model for workflow management systems.

Workflow Approach

History

The concept of workflow emerged in the early 1990s as a result of research on software tools for facilitating collaborative work. It focused on structured or potentially structured processes involving different actors within an organization. The objective was to improve productivity and quality by assisting with document flow and addressing issues like queueing, delays, and coor-

dination. Workflow became closely associated with Electronic Document Management Systems (EDMS) or Document Management Systems (DMS). Organizations adopted workflow management systems to automate and optimize processes, achieving efficiency, transparency, and control. Recent advancements integrated technologies like AI, RPA, and machine learning, enabling intelligent decision-making and automation. Workflow management remains crucial for organizational efficiency, as organizations seek to enhance processes, reduce manual efforts, and foster seamless collaboration. [13]

Definition

There are numerous definitions that refer to the "workflow" term. The Workflow Management Coalition (WfMC) defines a workflow as :

Nurcan, S. (1996), Workflow is a *"The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules."* [15]

Marshak (1994) also defined workflow as follows: *" A Workflow simply refers to the processes we use every day to do our business. A workflow application automates the sequence of actions, activities, or tasks required by a work process. It also tracks the status of each process step, and manages the process itself."*[6]

Meaning a workflow can be defined as a series of interconnected tasks or activities that are carried out in a specific order to achieve a desired outcome or goal. It involves the systematic and organized movement of information, resources, and actions across individuals or departments within an organization. Workflows provide a structured framework for coordinating and managing business processes, ensuring that tasks are completed in a timely and efficient manner.

Basic Workflow Concepts

The concepts of the workflow have been summarized by Marshak's "3Rs"(Routing, Rules, Roles):[20]

- **The routes** (itinerary of the information and document transformation process): the routing or circulation of documents, information, or tasks is the first major function of the workflow.
- **The rules** (action procedures): the management of activity coordination rules is the second main function of the workflow. It is complementary to the first insofar as the itinerary of a process depends on the rules which define both the nature of the information and its mode of transition from one person to another. These rules can be simple or complex, but they are essential to the operation of a workflow.
- **The roles** (the skills of the different participants): the third main function of the workflow consists in assigning roles to the actors of the workflow. A role is associated with the performance of one or more tasks. This can be assigned to several actors and an actor can perform several roles.

The main functions of a workflow application

Today, companies are entering the area of e-business, and to remain competitive, they must constantly improve their operational efficiency. Consequently, the new Information Technologies and more particularly the Internet became an essential vector of communication. Moreover, harmonizing the work of the human in a global information system became a priority. Faced with these challenges, workflow functions provide standardization and automation that allows teams to gain in efficiency significantly, organizations to achieve their quality objectives, and reduce costs and lead times.

Generally, workflows support the following three basic tasks:

- ➡ managing work procedures.
- ➡ coordinating loads and resources.
- ➡ and supervising the flow of operations.

. The achievement of these tasks is carried out through the multiple functionalities available, among which we can mention:[25]

- Routing of workflows to the departments concerned.
- Event management.
- Management of human actions and automatic actions in the same workflow.
- Creation of business rules based on workflow data.
- Create conditions or exceptions based on workflow data or use macros.
- Customization of content and display of event notification emails.
- Action escalation management based on workflow data.
- Management of the delegation of the actions of the participants of the workflows.
- Creation of complex workflows with sub-processes.
- Customizing and securing the display of workflow data.
- Ability to attach any type of attachment to the workflow.
- Definition of electronic forms.
- Workflow data stored in a database.
- Different possible assignment methods (automatic, self-service, dynamic, etc.).
- Circuit management: in parallel or in series.
- Definition of a deadline for the entire workflow.
- Definition of a deadline for carrying out the actions during the
- Design of the workflow or when the latter is being executed.
- Launching a workflow from a third-party application.
- Unique identification number for all workflows.

Finally, we can see that the Workflow provides an effective solution for:

- > Model work processes.
- > Control and monitor the progress of projects.
- > Automate document circulation.
- > Involve the partners in the procedure.
- > Measure costs.

Fundamental Workflow Terminology

The main terms associated with workflows proposed by the Workflow Management Coalition (WFMC), which belong to the workflow lexicon, are presented below:[11]

Workflow

The orchestrated and repeatable pattern of business activity is enabled by the systematic organization of resources into processes that transform materials, provide services or process information.

Process

A set of related activities that transform inputs into outputs, following predefined rules and guidelines.[5]

Activity

A unit of work performed within a workflow that contributes to the achievement of a specific goal or outcome.

Task

A specific piece of work that needs to be completed as part of an activity or process.

Actor

An individual or system entity is involved in the execution of tasks or activities within a workflow.

Data (Resource)

Any item, physical or virtual, required for the execution of tasks or activities within a workflow.

Workflow application areas

There are many uses for workflow in the modern world. The adoption of this technology resulted from the company's organizational processes evolving. It satisfies the need to maximize productivity by utilizing resources efficiently.

Workflow is predicted to have a significant impact on the financial sector, including banking and insurance systems (providing loans, processing refunds, etc.). It can be extended to any cyclical work process in the business world.

We are additionally interested in its uses in the field of information technology, such as the software development cycle. We can connect the gradual integration of a software's components with the intended organization by incorporating the cooperative work feature into the workflow. Thus, the project manager has a tool for monitoring the project's development and the system's consistency regarding deadlines. Workflows can also be utilized in organizations that are not businesses, such as administrations as municipalities, and university scientific research laboratories. [19]

Workflow in the laboratory

Workflow in the laboratory is a collection of linked actions that arrange the management of the laboratory. These processes include organizing the many tasks that will be carried out in the lab, figuring out the resources required to carry them out, and defining work schedules. Utilizing the workflow, the laboratory may manage its activities with greater efficacy and efficiency while

meeting the specified goals with high-caliber results

Advantages of workflow

Some of the key advantages of workflows include:[9]

- ✓ Guarantee and optimization of work processes.
- ✓ Increase in productivity, efficiency, and transparency.
- ✓ Less effort on communication.
- ✓ Less time spent passing on items or waiting.
- ✓ Fewer errors.
- ✓ Faster entry of information and documents.
- ✓ Decisions and measures can be met more quickly.
- ✓ Flexible adaption to work processes and employee organization.

Conclusion

In this chapter we introduced the concept of groupware, then we defined the workflow. Secondly, we looked at the basic concepts, technical typologies, and functionalities. Finally, we talked about The main functions of a workflow application. In the next chapter, we will focus on the presentation of the concept of process and its modeling using the BPMN method.

Chapter 3

Methods And Tools

Introduction

In this chapter, we will discuss "Methods and Tools" for process management. We will explore the definition of processes and their types, as well as delve into the realm of business process management (BPM) and business process modeling techniques and methods. Additionally, we will conduct a comprehensive study of BPMN (Business Process Management and Notation), and BPMS (Business Process Management Suites), and specifically focus on a detailed analysis of Bonita software BPM.

Definition of a process

A process is a set of interacting activities that, from a set of inputs, produce a set of outputs to achieve a given objective. These activities are performed by machines or human actors to whom roles are assigned, They may involve resources and are sometimes conditioned by events. The process starts with the customer's needs, with customer satisfaction as its ultimate goal. [8]

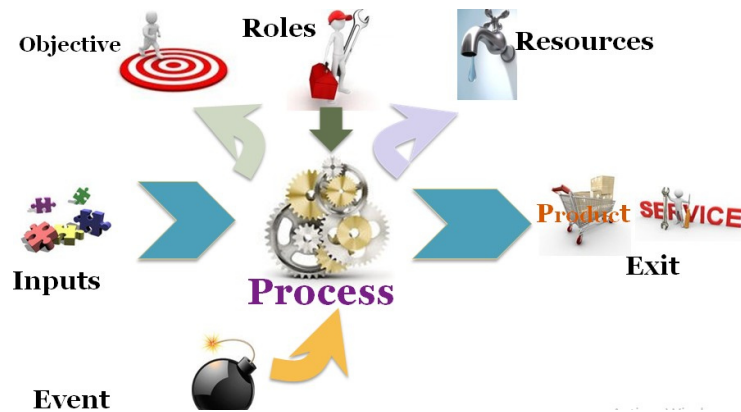


Figure 3.1: Process

A process, therefore, has the following characteristics:

- Represents a dynamic view of the organization (sets a goal).
- Has one input and one output.
- Is composed of sub-processes followed by activities, which are the atomic components of the activity.
- An activity describes the conversion of an input resource into an output resource.
- An activity graph, which shows the progression of tasks required to achieve the objective.
- Increase the value of goods or services.
- The **roles** that represent the organization of the procedure.
- A transition function that manages the progress of the procedure.
- **Resources** are the means, knowledge, or tools used by an activity.

Types of Processes

Organizational processes are divided into three categories: business processes (those that are presented to clients on the outside of the organization and are visible to them, such as management of the market), support processes (those that provide the resources that professional

processes need), and management processes. They are not obvious from the outside, such as the development of computer systems, and management processes (those that provide the tools for managing professional processes, such as piloting).[24]

Support processes

(of execution or operational): They directly contribute to the creation of the product from the client's need to their pleasure. They group together activities that are involved in the life cycle of the product, such as product development, purchasing and provisioning, logistics, manufacturing, and marketing.

Management processes

The management process re-states the strategy, and the goals, and allows for the direction of the quality initiative while ensuring continuous improvement. These include, for instance, the processes for planning activities, managing improvement, or defining and monitoring goals.

Business processes

A business process is a well-organized group of logically connected tasks that is a recurring area of work that is started by a business event. The process is guided by business rules that activate tasks and sub-processes and assign resources from various specialties to them to accomplish its objective, which could be for an internal or external customer.

Business Process Management

3.4.1 Definition of a Business Process

There are various definitions attributed to the term "process." According to the ISO 9000:2000 standard, a process is described as "a set of correlated or interactive activities that transform input elements into output elements."

The WfMC defines a process as a "coordinated set of actions that are linked in series or in parallel to achieve a common goal."

Mougin Y (2002) defines a process as a black box with a purpose (the output data). To accomplish this purpose, it utilizes external elements (input data) and transforms them by adding value through work and tools (activities and resources).

Morley and al (2011) define a process as "structured sets of activities conducted with a specific objective, assigned to one or more actors corresponding to different roles, and executed using resources."

Brandenburg and Wojtyna (2003) define a process as a sequence of activities or sets of activities that receive inputs, utilize resources, and add value toward the goal to create outputs.

In essence, a business process is a collection of activities undertaken with a specific objective. The responsibility for carrying out these activities, either entirely or partially, lies with an actor fulfilling a specific role. The execution of the process involves the utilization of resources and may be influenced by internal or external events. The arrangement of activities corresponds to the structure of the process. From these definitions, we can identify key concepts such as objective, activity, role, resource, and event, which form the foundation of defining a business process. [8]

Business Process Modeling

Business process modeling consists of defining, representing, and documenting the tasks performed in the company, both by humans and by IT tools. It allows us to understand and formalize existing processes to document them, improve them, or automate their management. It also helps to experiment and simulate new concepts to see their impact on the organization. The main ideas that need to be expressed in a modeling language or formalization (notation) are as follows:[18]

BPM Life Cycle

In the BPM workflow, a business process must be designed, modeled, executed, monitored, and optimized. A model of the business process must be created to complete these life-cycle

phases. A business process model depicts the flow of steps that must be taken to achieve a particular goal for the organization. be carried out to give the group a particular outcome. [14]



Figure 3.2: BPM Cycle

- Sub-processes can be separated into each process.
- Each process or sub-process can be broken down into a task enumeration graph.
- Each task is carried out by an actor (human, computer, or logician).
- A process is started by a beginning event, and depending on how it plays out, it may have several potential endings, each of which can set off a final event. Waiting for a middle event may also cause its course to be interrupted. Additionally, it may cause subsequent intermediate events.

Business process modeling techniques and methods

The modeling of business operations has been a very active area of research in recent years. Even though they did not refer to their models as "models of process businesses," people have been simulating business processes for many years. There are many modeling methods, and the following are just a few:

The OSSAD method (Office Support Systems Analysis and Design):

Is a methodology and language that allows for the analysis, evolution, and improvement of an organization's state. It is the result of a funded research project by the European Community under the ESPRIT initiative. (European Strategic Program for Research in Information Technology). It takes resources to successfully implement a reorganization of an organization's or administration's processes, both for their detailed description and for their positioning in relation to the organization's goals. To best serve itself in a reorganization project, OSSAD offers these tools and outlines general guidelines.[7]

UML (Unified Modelling Language) :

UML (Unified Modeling Language) is a language designed to represent, specify, construct, and document artifacts of predominantly software systems. It provides a standardized way to express the development and construction plans for software. UML encompasses both conceptual elements, such as business processes and system functions, and concrete elements, such as classes written in a programming language, database schemas, and reusable software components.

UML serves as a notation for graphically translating software system models. While technically a language, UML expresses concepts from a specific perspective. In practice, UML adopts an object-oriented approach to represent and design systems, whether they are conventional management applications or embedded real-time systems.[10]



Figure 3.3: UML

BPMN (Business Process Management and Notation):

With the introduction of "**Business Process Management**" (BPM), the market, users, consultants, and technology suppliers have reached a point of maturity where it is possible to suggest

a common notation for representing business process diagrams that have been endorsed by the vast majority of users and are being used by the majority of software developers in the industry. This is what **BPMN**, or business process management notation, aims to achieve. (BPMN). We have decided to use this method to describe our workflow. [23]

Study of BPMN

Introduction

Organizations depend on collaboration and communication. To complete tasks, the team members collaborate. To maximize their mutual benefits, groups, even whole businesses, share knowledge and insights. Organizations are working to reduce communication costs among parties to guarantee high yields. Because it increases organizational effectiveness, and productivity, and lowers operating expenses, business process modeling has drawn a lot of attention. BPM is being used by organizations to better comprehend how business processes are carried out, how parties collaborate, and how to increase productivity.

Definition

BPMN (Business Process Model and Notation) is a standardized graphical language used to model business processes. It provides a graphical notation for representing activities, events, sequence flows, message flows, decisions, branches, clusters, pools, and lanes, among other process elements.

BPMN is designed to be understandable by business users as well as IT professionals. It is used to model complex business processes to make them easier to understand, communicate and improve. BPMN diagrams are often used to document existing processes, identify problems and bottlenecks, and propose improvements. BPMN is supported by many process modeling tools, allowing organizations to create BPMN diagrams efficiently and collaboratively. The language is maintained by the Object Management Group (OMG), a non-profit organization that develops standards for information technology. Specifically, BPMN accomplishes the following:

[23]

1. Process visualization: This technique presents a business process graphically, which is much more effective than textual depiction.
2. Documentation - To define both process-specific properties and a detailed description of business activities.
3. Communication - BPMN offers a basic set of notations that anyone can read and grasp to describe a business process. It is simple to exchange and debate ideas over the phone or in meetings.

History

The Business Process Management Initiative (BPMI) is responsible for the creation of BPMN, which was first developed in 2004. BPMN represents an undeniable advancement in the construction of graphed processes.

The ability to describe executable processes was one of the BPMN version 1.0's original goals. Numerous features, including activities for error compensation or handling exceptions, were incorporated as a result. These characteristics initially gave the notation the appearance of being complicated and unfit for modeling business operations. However, in practice, the standard has been applied at all stages of process analysis (analysis of the value chains and services provided, analysis of the actors' work processes within the company, and analysis of application processes).

ˆ In February 2006, the OMG adopted version 1.0.

ˆ In January 2008, the OMG delivers version 1.1.

ˆ In January 2009, the OMG delivers version 1.2.[22]

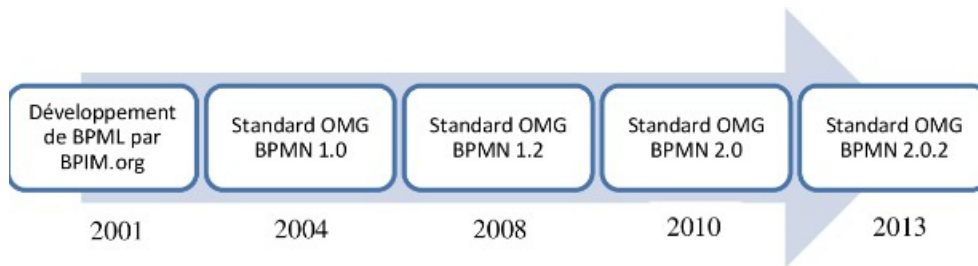


Figure 3.4: History of BPMN

BPMN 1.2 was a non-executable graphic notation. To implement the BPMN models through executable language conversion systems, more or less formal methods have been developed. The majority of the time, the methods involved using BPE (Business Process Execution Language). (BPEL).

The main graphical elements of BPMN

The different elements are organized into three categories.[\[17\]](#)

- Flow object.
- Connection object.
- Swimlane.

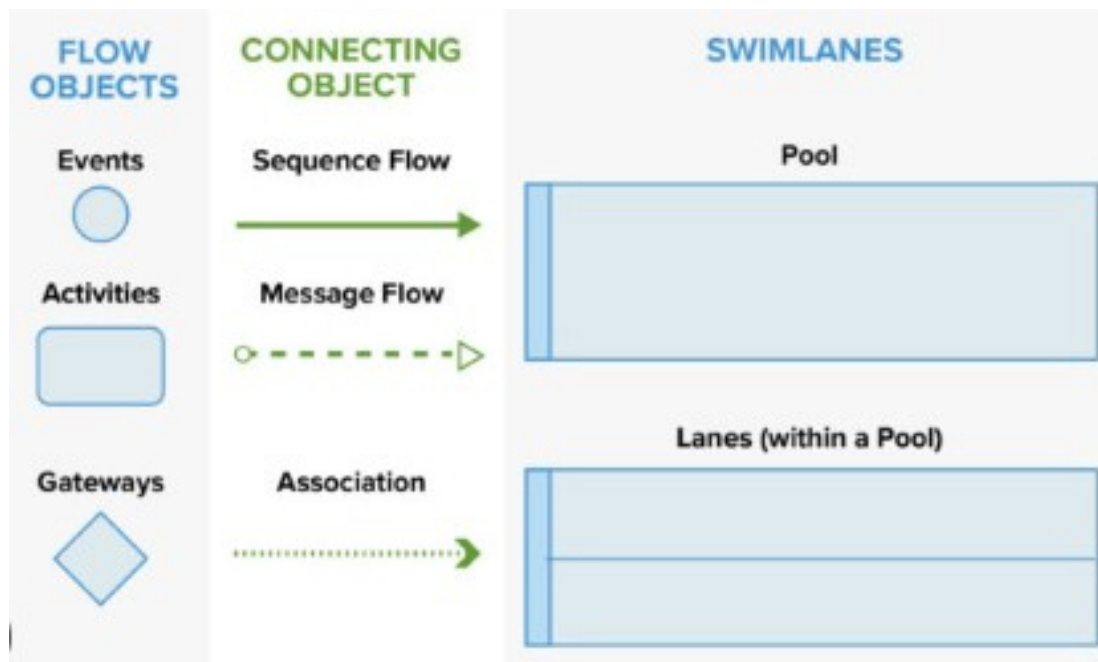


Figure 3.5: Flow elements

✓ **Flow objects:** includes three primary object types: activities, events, and conditional branches (gateways).

➔ **The activities:**

The work completed as part of a process is known as the activities, which can include various kinds of tasks. (human task, launch a service, script, send an email ...). The task's nature is indicated in the activity's upper-left corner. If a process (sub-process) is also an activity, a + is shown at the foot of the activity. The tasks are subdivided into :

➤ **Tasks**

A task is an indivisible element. It represents an action, each task has a beginning and an end and therefore a task can only start if the previous task is finished, a task has a type that allows specifying its functioning: a service, a sending, a receiving, a human task, a script, a manual task, or an abstract task.

The tasks are subdivided :



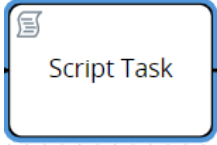
Tasks	Human	Service	Script
Description	As suggested by the name these are tasks carried out by a person within the flow of a process.	Through services, they enable connectivity between an external system and the process.	Permit writing system code to act within the flow of the process without human interaction
Symbol			

Table 3.1: Table of tasks

➤ **Sub-processes**

A sub-process is a task that is broken down. It is represented by a rectangle with rounded corners and a small "+" to access the details. A double click on a task with a "+" sign opens the detailed model of the task. Sub-processes can be subdivided into reusable and embedded:



Sub processes	Reusable	Embedded
Description	It includes a group of tasks that can be called from various phases of the procedure because they are independent of the beginning of the procedure.	Contains a number of activities, but none of them stand alone from the initial process.
Symbol		

Table 3.2: Table of tasks

➤ **Called process**

It is a complete process that is called another process.

A called process is an independent process that is called from a call activity in a parent process, the process flow goes from a call activity in the parent process to the start element in the called process, while the called process is executing, the parent process is paused when the flow reaches an end element of the called process, processing returns to the call activity [4].

➡ **Events**

Everything that "happens" during a business process that affects the process flow typically has a cause (trigger) or an effect. (result-ado). Three fundamental types of events are Initial, Final, and Intermediate.

➤ **Initial**

The process is started as a result of certain occurrences. They are symbolized by a circle with a thin line.








Type	Description	Symbol
Basic	Without any specific information about the trigger, the event is initiated. It can also be used to show that a sub-process is running.	
Message	The event starts after one person receives a message from another.	
Timer	The event is triggered after a delay	
Condition	The occurrence is brought about by the affirmation of a rule.	
Link	Source and destination link of an activity.	
Multiple	When one or more triggers aren't activated, a process's execution is halted.	
Error	This event is used to deal with process-related errors that happen.	

Table 3.3: BPMN Initial Event

- **Intermediate** gives you the option to indicate that a certain sort of event is waiting in the middle of a flow. The flow is halted, for instance, while the event "receipt of a message" is still pending. A circle with a double outside line is used to represent them.








Type	Description	Symbol
Basic	It denotes one or more process state shifts. Only intermediate events situated in the primary activity flow of the business process continue to fall under this category of the event.	
Message	While awaiting the receipt of a message from a participant, the procedure is interrupted.	
Timer	While awaiting the passage of a specific amount of time, the procedure is halted.	
Condition	used exclusively when managing exceptions. When a rule's evaluation yields a true Boolean result, this kind of event is initiated.	
Link	Source and destination link of an activity.	
Multiple	When one or more triggers aren't activated, a process's execution is halted.	
Error	Exceptions that arise during the procedure are handled using this event.	

Table 3.4: Intermediate event of BPMN

- **Final** A path in the Process will terminate at the location indicated by the terminate Event. The conclusion of a process can vary. When all of the active paths have concluded, the process is over. No outbound sequence flows exist for end events.






Type	Description	Symbol
Basic	is the fundamental one and enables a generic representation of all situations.	
Stop	implies that all process activities must end right away after this one is executed. Of course, this includes any instances that might occur throughout the process.	
Link	A token arriving on this event is immediately forwarded to the target process's associated initialization event or intermediate event.	
Multiple	enables the possibility of triggering multiple events at once. For instance, to send numerous messages at once (an event of Fin of type "Message" cannot be used because it would only send one message), or to send a message, a signal, and an error all at once. As a result, it makes it possible to create a procedure ending with the desired elements.	
Error	Exceptions that arise during the procedure are handled using this event.	

Table 3.5: Final event of BPMN

➔ Gateways

They are used to control the flow of sequences, as well as the separation and convergence of activities. They determine branches, paths, merges, and route junctions.

- Gateway exclusive (XOR)

branch point giving rise to conditional, mutually exclusive, alternative outflows. Only 1 path will be chosen when the condition associated with it is validated.

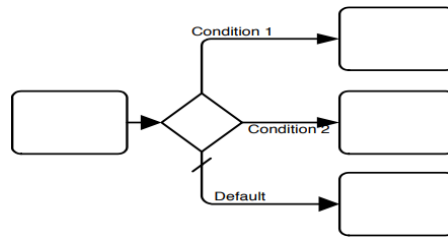


Figure 3.6: Merge XOR

- **Gateway exclusive (OR)**

Synchronization point (Join) OR: point of connection giving rise to an exclusive combination of several incoming flows (only 1 is required to trigger the necessary to trigger outgoing flow).

When the inbound flows are alternative, there is no gateway.

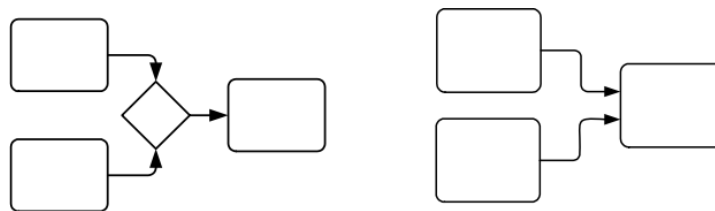


Figure 3.7: Join OR

- **Gateway inclusive (OR)**

The merge point OR is The branching point that allows for parallel conditional flows (concurrent flows), all the flows whose associated conditions are validated will be chosen.

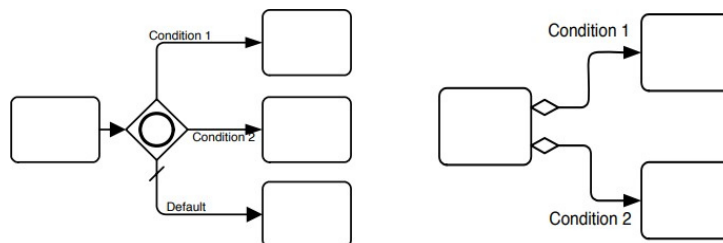


Figure 3.8: Join OR

- **Gateway parallel (AND)**

As with the incoming flow, the synchronization point (join) watches for all incoming flows before starting the outgoing flow.

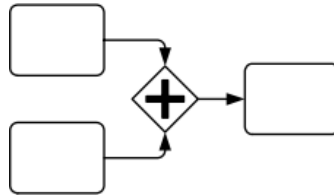


Figure 3.9: Gateway parallel

- **Event Gateway**

Branch point where related events cause outgoing alternate flows to be performed

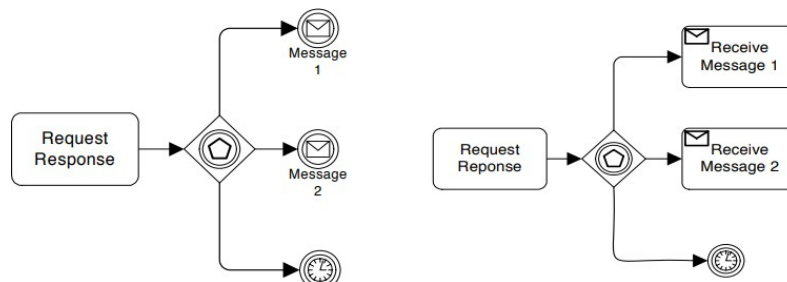


Figure 3.10: Event Gateway

✓ **Connection object:**

There are three different kinds of connection objects that can connect flow objects. (sequence flows, message flows, associations).


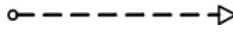

Type	Description	Symbol
Sequence flow	shows how a process's various activities should be carried out in sequence.	
Message flow	shows how messages are exchanged between two process actors. (2 pools)	
Association	Associating information or artifacts with graphic elements, such as textual annotations to BPMN's graphical components. It is possible to designate the flow direction.	

Table 3.6: BPMN Initial Event

✓ **Swimlane:** In order to group all processes and activities involving the same participant into a "pool" and to organize the processes and activities within a "pool" using "bandes", corridors are used to graphically organize the process diagram. (Lanes)

* **Pool:** Represents a participant within the process flow. It acts as a container to separate a set of activities within the pools.

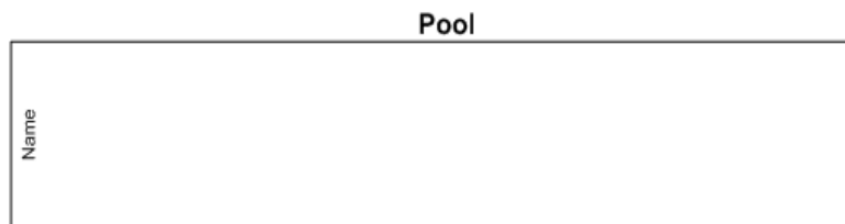


Figure 3.11: Representation of a Pool in BPMN

* **Lane:** A subdivision within a pool that extends the entire length of the pool either horizontally or vertically. It is used to establish or categorize activities.

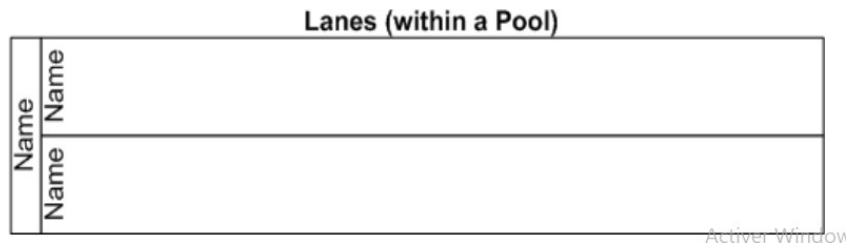


Figure 3.12: Representation of a lane in BPMN

Business process management suites (BPMS)

It is a collection of BPM technologies that include functional modules, technical capabilities, and infrastructure that is integrated into a unified environment. It seamlessly performs all BPM functions without any errors, making it a complete package. BPMS is more than just a solution, it is currently the preferred technology for supporting business processes in web architecture. It is a generic software system that includes tools to cover the BPM lifecycle within organizations, enabling the automated and flexible management of business processes through the design of process models. BPMS is essentially software that supports BPM and has a practical focus, as it introduces theoretical approaches to the system, automating them to the greatest extent possible while ensuring compliance and providing necessary analysis for continuous improvement. In any case, most agree that a BPMS must contain at least the following functionalities:[21]

- **Process Diagrammer:** Tool to draw the process.
- **Orchestration Engines:** They allow for coordination of the sequence of activities according to the flows and rules of the Process Classes.
- **Form Designer:** Tool for defining forms and reports that are not available in the components that are needed to support the design process.
- **Process Intelligence:** BAM (Business Activity Monitoring) Tools, BI (Business Intelligence), Dashboard, KPIs (Key Performance Indicators), etc.

- **Integration Tools:** They allow the model to be integrated with other systems, such as ERP or the company's legacy systems.

3.7.1 BPMS tools

In today's dynamic business environment, organizations constantly seek ways to streamline their operations and improve efficiency. One of the most effective ways to achieve this is through the use of business process management (BPM) tools. Bonita software is one such BPM tool that has gained popularity among businesses of various sizes and industries.[21]

BonitaSoft

Bonita software was created in 2001 by Miguel Valdés Faura, a computer engineer who worked at the French National Institute for Research in Computer Science and Automation (INRIA). He co-founded the project and later established Bonitasoft in 2009 with Charles Souillard and Rodrigue Le Gall. Bonitasoft has now been recognized as the leading provider of Business Process Management (BPM) solutions.

Bonita software features a user-friendly graphical process modeler that simplifies the deployment of BPM applications with just a few clicks. The solution automatically generates forms or allows for advanced configuration options. The company's goal is to become the top open-source BPM provider and deliver flexible, powerful BPM solutions for all types of organizations. Bonita provides components for manipulating, executing, and controlling:[7]

- Task automation.
- Assignment of tasks to users.
- Process execution.

Presentation of the Bonita platform

Bonita is an open-source business process management (BPM) platform and **low-code** software. It provides a comprehensive set of tools and features for modeling, automating, and optimizing business processes within organizations.

The Bonita platform enables businesses to visually design and model their processes using a graphical interface. Users can define the sequence of tasks, actions, and decisions required to complete a specific business process.[7]

Once the processes are defined, Bonita offers capabilities for automating and executing these processes. It provides workflow engines that manage the execution of tasks, handle user interactions, and enforce process rules and policies. Bonita also supports the integration of various systems and applications, allowing for seamless data exchange and collaboration.

In addition to process modeling and automation, Bonita offers features for process monitoring, reporting, and optimization. Users can track the progress of running processes and generate reports to gain insights into process efficiency and identify areas for improvement.

As an open-source platform, Bonita offers flexibility and extensibility. It provides a community-driven ecosystem with a range of add-ons, connectors, and integrations that enhance its functionality and adaptability to different business needs.

Bonita BPM is composed of three main parts:[3]

1. **Bonita BPM Studio:** provides a graphical environment for designing and creating business processes. It includes a variety of features that are easy to use, including the ability to create and run process tests on a local computer, and a panel of ready-made connectors for messaging, databases, enterprise resource planning, enterprise content management, and customer relationship management.
2. **The Bonita BPM Platform:** is made up of the:

- **Tomcat Application Server:** used to run the Bonita Execution Engine.

- **Bonita BPM Portal:** This is a web-based interface that provides access to all the features and functions of the Bonita BPM platform.
 - **The Bonita BPM Engine:** is a Java application that executes business processes created in Bonita Studio.
 - **The H2 database:** is automatically generated on the first startup and can be used for all the above functions. However, it is only suitable for testing purposes. If you create a production environment, you must switch to a different RDBMS.
3. **The Bonita User Experience:** is a portal that allows end-users to manage tasks and provides process owners with administrative features and reporting capabilities. Bonita Studio is built on the Eclipse platform and is compatible with other process design standards, making it a versatile and adaptable tool.



Figure 3.13: BonitaSoft

Advantages of the Bonita BPM:

Some of the key advantages of workflows include: [21]

- The program has a rich library of example models that enable users to create readable graphics easily. By simply dragging and dropping, users can progress through their designs without having to start from scratch. The software's model library allows for a wide range of ideas and constant progress during the design process.
- The program's graphic model base allows users to freely control the drawing of all vectors. It also supports the insertion of graphics and objects in other formats, which

- reduces the amount of user input required.
- The software simplifies and streamlines the design process by providing configuration options for formatting, layout, and centralized layer control. As a result, users can easily create flow diagrams, network diagrams, and software design diagrams for various specialties.
 - The software allows users to save their designs in a special Bonita format or different common graphic formats. They can also directly insert the created graphics into an Office program for use as a supplementary file.
 - The Bonita platform is based on a unique approach to low-code applied to BPM. It clearly separates visual development capabilities from coding options, allowing developers to use their existing tools and methodologies when they want to code.[2]

The connectors used in Bonita

In Bonita, connectors are components that facilitate the integration of the BPM platform with external systems or services. Connectors enable data exchange, interaction, and communication between Bonita processes and external applications, databases, APIs, or web services.

Bonita provides a variety of connectors that can be used to integrate with different systems and technologies. Some commonly used connectors in Bonita include: [4]

Email Connectors

Bonita provides connectors for sending and receiving emails. These connectors allow you to incorporate email notifications, alerts, or communication within your Bonita processes.

Database Connectors

Bonita supports connectors for various databases, allowing you to connect to and interact with databases such as MySQL, Oracle, PostgreSQL, and more. These connectors enable you to retrieve data from databases or update database records within Bonita processes.

REST and SOAP Connectors

Bonita provides connectors for integrating with RESTful and SOAP-based web services. These connectors allow you to make HTTP requests to external services, consume their APIs, and exchange data with them.

Template connector

Bonita offers connectors for reading and writing files, allowing you to interact with local or remote file systems. These connectors enable you to handle file operations within Bonita processes, such as reading data from files or storing process outputs.

Document converter

The Generate PDF from an Office document connector converts a document from .odt or .docx format to PDF.

Adobe Acrobat Sign

Adobe Acrobat is a popular software program developed by Adobe Systems that allows users to view, create, edit, and manage PDF (Portable Document Format) files. It provides a wide range of features for working with PDF documents, including the ability to add digital signatures to PDFs. Adobe Acrobat Sign allows us to sign documents electronically,

either by typing your name or drawing your signature with a mouse or stylus. It also supports digital certificates for more secure and legally binding signatures. Adobe Acrobat Sign is commonly used in various industries for document management, collaboration, and electronic signatures.

To integrate Adobe Acrobat's signature feature into Bonita, we will need to perform custom development steps using Bonita BPM's capabilities. Here is a general approach to integrating Adobe Acrobat Sign in Bonita:

- **Configure signature fields in Bonita:** In the Bonita process, we can create a form that includes a signature field where the user can place their signature. These fields will serve as the trigger for the Adobe Acrobat signing process.
- **Call Adobe Sign API from Bonita:** We used Bonita's features to call the Adobe Sign API to initiate the signature request for the PDF document.
- **Manage workflow and signature statuses:** Bonita can be used to manage the workflow for the signature request. we can define steps for approval, validation, and signatory notification. At each step, Bonita can communicate with Adobe Sign to retrieve information about the signature status and update the process status.
- **Retrieve the signed document:** Retrieve the signed document: Once all signatories have placed their signatures on the PDF document using Adobe Sign, we can use Bonita's features to retrieve the signed document and store it in our system or transfer it to other steps in the process.[16]

Sharing Project

3.11.1 Git SCM (Source Control Management) :

In Git, a branch is a separate line of development that allows you to work on different features or fixes without affecting the main codebase. Each branch consists of a series of commits, which are snapshots of the code at a particular point in time.

Commits represent the changes made to the codebase. They include the modified files, a

unique identifier, and a commit message describing the changes. Commits provide a way to track the history of changes and revert to previous states if needed.

When we want to incorporate the changes from one branch into another, you have two options: merge and rebase.

- **merge** changes from one branch to another by creating a new commit that represents the merge. This allows you to batch the changes together while maintaining a commit history for both branches.
- **Rebase** on the other hand, allows you to move the commits of one branch onto another. It essentially replays the commits of the feature branch on top of the target branch, resulting in a linear commit history. Rebase is often used to maintain a cleaner and more streamlined commit history.

To **collaborate** with others, Git provides the concept of **remote repositories**. A remote repository is a copy of the repository hosted on a different server or location. Developers can **push** their local commits to the remote repository to share their changes, and they can also pull changes from the remote repository to update their own **local repository** with the latest code.

When **pulls** changes from a remote repository, Git performs a fetch operation to retrieve the changes from the remote repository without merging them. It updates the remote-tracking branches in the local repository. After fetching, you can choose to merge the changes with your local branch or rebase your branch onto the updated remote branch.

In short, **branches** allow us to work on separate features, commits capture changes made to code, merge and re-merge changes between branches, remote repositories facilitate collaboration, and drag and fetch are the operations used to retrieve and merge remote changes into the local repository.[\[12\]](#)



Figure 3.14: Git SCM

Conclusion

In this chapter, we have introduced the concept of process, and we have emphasized the concept of business process, as well as the techniques of its modeling.

The next chapter will be devoted to the analysis and design of our workflow application using the graphical notions of BPMN for the modeling of our business process.

Chapter 4

Analysis And Modeling

Introduction

This chapter offers an extensive overview of the activities conducted by the "L'INFI" laboratory. It covers various aspects such as the members of the laboratory, its internal organization, assigned tasks, and the processes involved. In addition, we have provided a detailed description of the different activities within the processes and the actors who participate in each activity. To visually represent our process, we used Bonita software, which is a graphical modeling tool. By employing this tool, we were able to create a graphical representation of our process, capturing various activities and actors involved.

After completing the process modeling phase, we are now ready to proceed to the next chapter, where our main objective is to generate a workflow application using the open-source BONITA software. This software will enable us to design and implement our workflow application based on our proposed process model.

Presentation of the laboratory "L'INFI"

The "LINFI" Intelligent Computing Laboratory is located at Mohamed Khider University in Biskra City. "LINFI" is dedicated to advancing the knowledge and applications of artificial intelligence (AI). The laboratory's research focus includes machine learning, the development of formal solutions, artificial vision, and multi-agent systems technology.

The "LINFI" is made up of four teams comprising 27 researchers, including graduate students and professors of scientific research. The research themes of the teams deal with many axes in the field of computing.[1]

Tasks

LINFI's missions revolve around three main areas: research and development (theoretical, applied), training and technology transfer of skills, and research results. This is done first through contracts involving companies via bilateral collaborations and consortia within the framework of national and international projects.

The scientific research objectives focus primarily on the development of formally validated solutions based on the principles of artificial intelligence such as learning, reasoning, pattern recognition and artificial vision, and multi-agent systems technology.

This is how the LINFI laboratory treats four major themes in its research activity: artificial intelligence and web applications, computer vision and shape recognition, semantic web and interoperability, and finally geographic information system. [1]



Figure 4.1: Lab logo

Organization chart of the laboratory

The organization chart of "LINFI" is represented as follows:

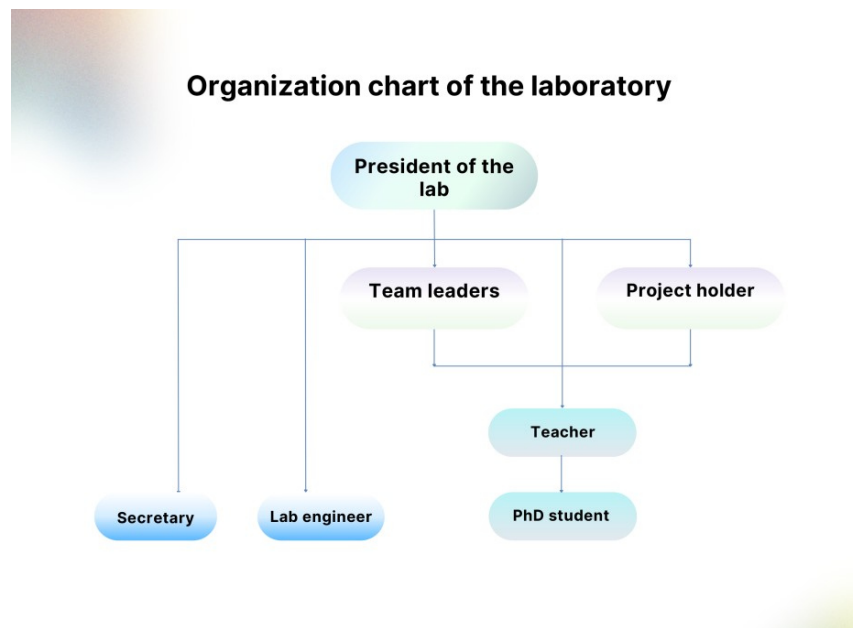


Figure 4.2: Organizational Chart

Laboratory members and some of their tasks

- **President of the lab:** a teacher of Professor rank.
- **Team leader:** An MCA rank teacher or professor.
- **Project leader:** A teacher of MCA rank. who will be appointed project leader after their project has been accepted by the ministry or by the 'DGRSDT' (national research directorate)
- **Teacher:** A teacher can have one of these grades (Prof, MCA, MCB, MAA, MAB)
- **PhD student:** A student who has passed the doctoral examination. He remains in the laboratory as a member until his defense or his resignation. He can ask for integration in the laboratory, he can ask for a plane ticket, and he can also be a member of a research project.
- **Lab engineer:** He Manages and operates equipment and systems in the laboratory, performs maintenance and updates, prepares reports, and provides technical support to lab members.

- **Secretary:** He manages the office, coordinates between management and employees, organizes appointments, meetings, and manages correspondence.

Purpose of Lab Process Digitization

The digitization of the process in a research laboratory presents several issues that may vary depending on the objective and environment of each laboratory.

The digitization process can bring benefits in terms of efficiency, speed, and accuracy of data, but it can also pose challenges in terms of data management, system compatibility, security, training, and costs. It is important to carefully plan digitization and implement effective strategies to overcome these challenges. We were able to identify the following shortcomings and deficiencies in the research laboratory:

- Poor task allocation and role disruption.
- The large volume of information processed manually sometimes generates errors.
- The difficulty of correctly managing documents (misclassified files in the laboratory which makes access and research difficult).
- Information insecurity.
- Loss of information records.

The study process

The objective of this part of our project is the modeling of some processes that occur in the research laboratory, using BPMN and Bonita open source.

Existing processes

- **Process 1:** Creation of a new research project.

Task	Actor	Description
Prepare the description of the Project.	A teacher who must have the MCA grade (he will be named project leader if his project will be accepted).	The description must contain more information and also the list of members from this project: teachers or Ph.D. students.
Send the project to the lab president.	Project leader teacher.	A Word file that contains all the project information.
Acceptance of the project by the president of the lab.	President of the lab.	Sending the detailed description of the project.
Organization of the lab council meeting.	President of the lab.	Here there is already a description of this process.
Sending the decision.	President of the lab.	Sending of the project decision (Either accepted or rejected) from the lab council to the project leader.
Receipt of the decision.	The project leader.	Here, according to the decision received, it can be revised and sent again to the president or transmitted to the faculty of the project.
Send the project validated by the lab council to the faculty.	President of the lab.	The Lab council sends its validation of the project.

Table 4.1: Process 1

➤ **Process 2:** Annual budget request.

Once the request has been validated by the Laboratory Council(LC), it will be sent to the rector's post-graduation(PG).

Task	Actor	Description
Prepare the budget request	President of the lab.	A Word document that will be prepared by the laboratory president.
Organization of the lab council meeting	President of the lab.	Here there is already a description of this process
Send the budget request to the rector's PG (post-graduation)	President of the lab.	Once the request has been validated by the LC, it will be sent to the rector's PG.

Table 4.2: Process 2

➤ **Process 3:** Lab Structure Update.

Task	Actor	Description
Update the lab structure to the president of the lab.	Secretary.	Excel file to be reviewed The Excel file represents the structure of the lab. Here it is about updating the Excel file by the secretary after requests have been granted, resignations, elections for a new president, new team leader, etc.
Send the new structure to President of the lab	Secretary.	Present the latest update of the Excel file to the lab President
Organization of the lab council meeting	President of the lab.	Here there is already a description of this process
Send the new structure of the lab to the PG (post-graduation) service of the rectorate	Lab President	Once validated by the lab council, it will be sent to the PG of the rectorate

Table 4.3: Process 3

➤ **Process 4:** Integration of new members in the laboratory.

Task	Actor	Description
Request to join the laboratory	Teacher	An integration request prepared by the teacher who wants to join the laboratory
Send the request to the laboratory president	Teacher	The teacher forwards the request to the lab president
Organization of the lab council meeting	President of the lab.	Here there is already a description of this process
Integration of the teacher in the lab and update of the lab structure	Secretary.	If the lab council is valid, we add the teacher

Table 4.4: Process4

➤ **Process 5:** Request a plane ticket

Task	Actor	Description
Preparing the request for a plane ticket	Lab member	A plane ticket request prepared by a lab member
Send the request to the laboratory president	Lab member	Transmission of the request
Organization of the lab council meeting	President of the lab.	Here there is already a description of this process
validated the request for a plane ticket	Secretary.	if the lab council is valid, we prepare an order form to send to the PG
Send the purchase order to PG	Secretary.	Sending the final version of the purchase order to the PG.

Table 4.5: Process 5

➤ **Process 6:** Purchase request for lab equipment.

Task	Actor	Description
Prepare the purchase request	president of the lab.	A Word file that will be prepared by the president of the laboratory
Organization of the lab council meeting	President of the lab.	Here there is already a description of this process
Send the request for purchase to the PG service of the faculty	President of the lab.	Once the request has been validated by the CL, it will be sent to the PG of the faculty

Table 4.6: Process 6

➤ **Process 7:** Organization of a scientific event.

Task	Actor	Description
Prepare the request for the organization of a scientific event.	Lab member	Establish a Word file that contains the request
Send the request to the laboratory president	Lab member	Transmission of the request
Organization of the lab council meeting	President of the lab.	Here there is already a description of this process

Table 4.7: Process 7

➤ **Process 8:** Organization of a meeting of the laboratory council.

Task	Actor	Description
Establishment of a convocation.	President of the laboratory.	The convocation contains the subject of the meeting, its date, and the points to be discussed.
Sending of the convocation to the team leaders.	President of the laboratory.	sending of the convocation by email to the team leaders by the president of the laboratory.
Sending of the convocation to the project leaders.	President of the laboratory.	sending of the convocation by email to the project leaders by the president of the laboratory.
Receipt of the convocation by the team leaders.	Team leaders.	Each team leader concerned receives the convocation.
Receipt of the convocation by the project leaders.	Project leaders.	Each project leader concerned receives the convocation.
Processing of the convocation by the team leaders	Team leaders	Each team leader does his treatment on the convocation
Processing of the convocation by the project leaders.	Project leaders.	Each project leader does his treatment on the convocation
Establishment of the response by the team leaders	Team leader	Each team leader accepts or refuses the convocation
Establishment of the response by the project leaders.	Project leaders.	Each project leader accepts or refuses the convocation
Sending of the response to the president of the laboratory by the team leaders.	Team leaders	Send the response to the president of the laboratory to attend the meeting.
Sending of the response to the president of the laboratory by the project leaders.	Project leaders.	Send the response to the president of the laboratory to attend the meeting.
Holding of the meeting of the members and study of the files	Lab council members	If (the number of participants ≥ 4) the meeting is held. - Otherwise (the number of participants < 4) the meeting is canceled.
Establishment of a PROCES VERBAL (PV) of the lab council	President of the laboratory.	
Announcement of "PV"	President of the laboratory.	PV is a paper document

Table 4.8: Process 8

Process modeling with BPMN

Modeling is the first phase in the BPM life cycle. This is to specify in which order the tasks should be executed in the process. We have chosen the BPMN method, which allows business analysts to represent processes in a simple and understandable way visually. We considered lab processes and elaborated its BPMN representation before submitting it for execution on BONITA open source.

Modeling our process:

In the following, we will present our process modeled by the BPMN notation using the graphical tool Bonita.

➤ **Process 1:** Creation of a new research project.

this is an independent process, and it is also called all processes in the lab process.

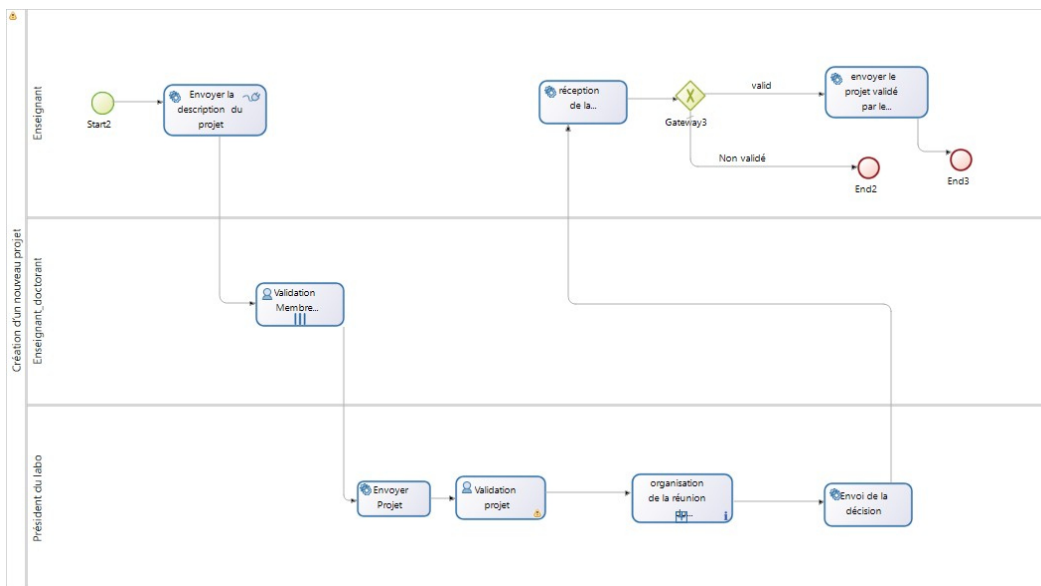


Figure 4.3: Model for Process 1

➤ **Process 2:** Annual budget request.

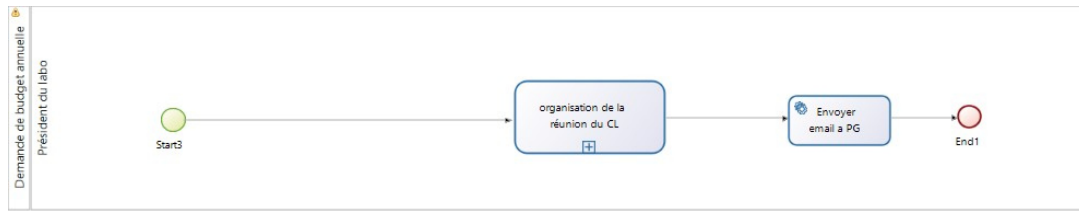


Figure 4.4: Model for Process2

➤ **Process 3:** Lab Structure Update.

This process already exists in the Bonita, in the function of the organization, which means that when we want to update the structure, it is sufficient for it to be updated through the organization only.

➤ **Process 4:** Integration of new members in the laboratory.

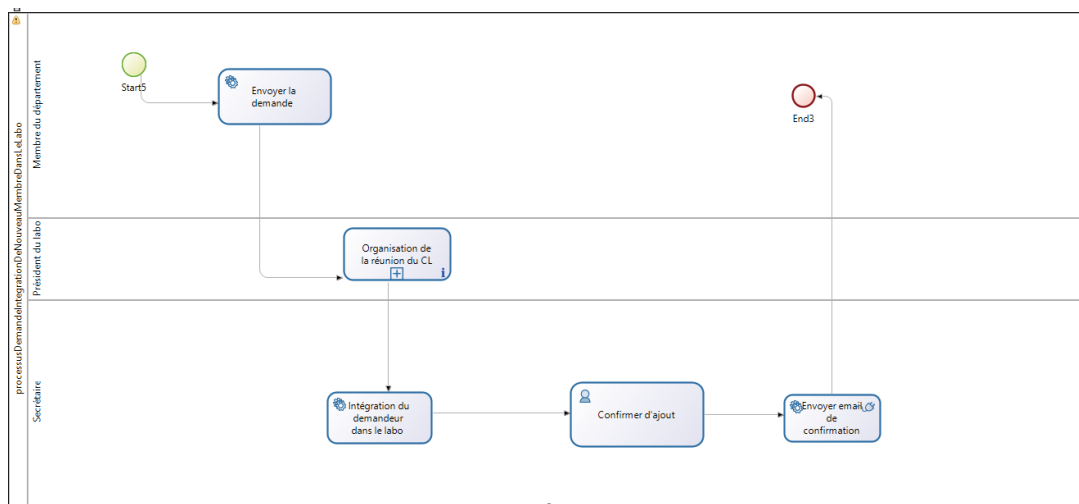


Figure 4.5: Model for Process4

➤ **Process 5:** Request a plane ticket.

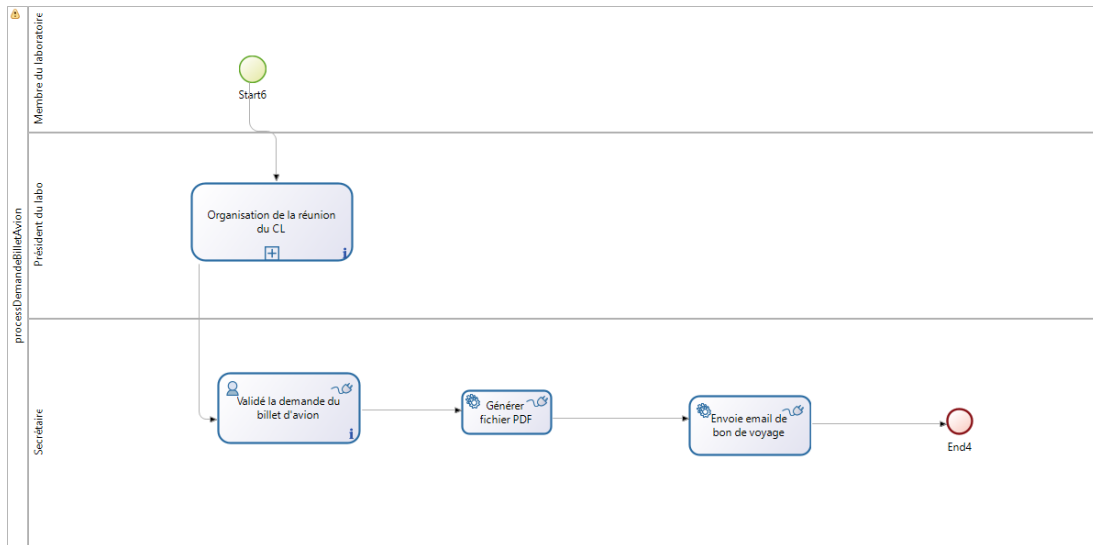


Figure 4.6: Model for Process5

➤ **Process 6:** Purchase request for lab equipment.

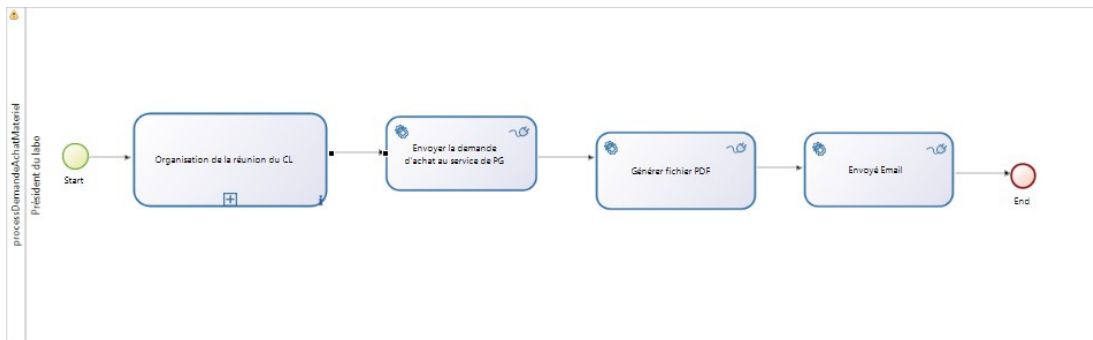


Figure 4.7: Model for Process6

➤ **Process 7:** Organization of a scientific event.

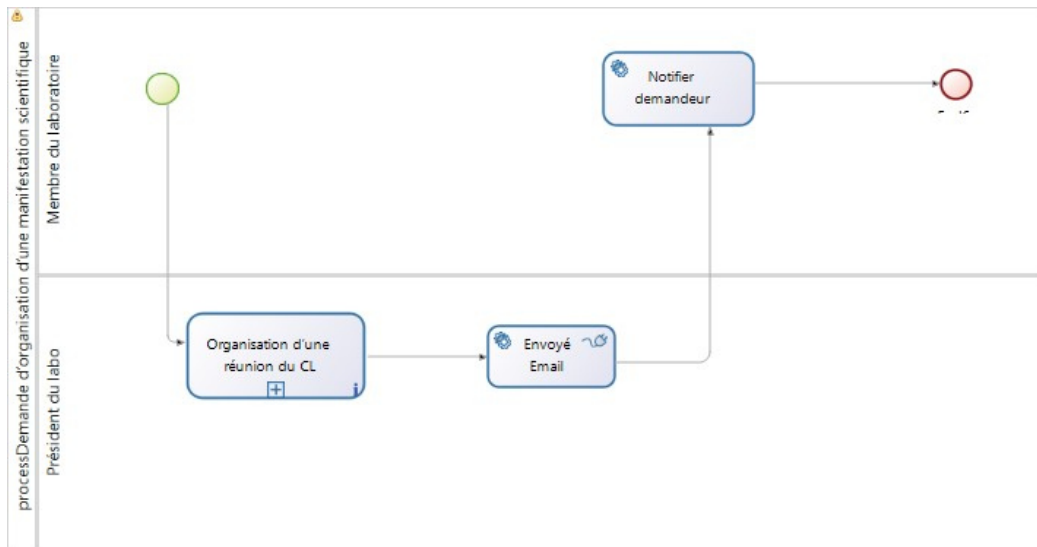


Figure 4.8: Model for Process7

➤ **Process 8:** Organization of a meeting of the laboratory council.

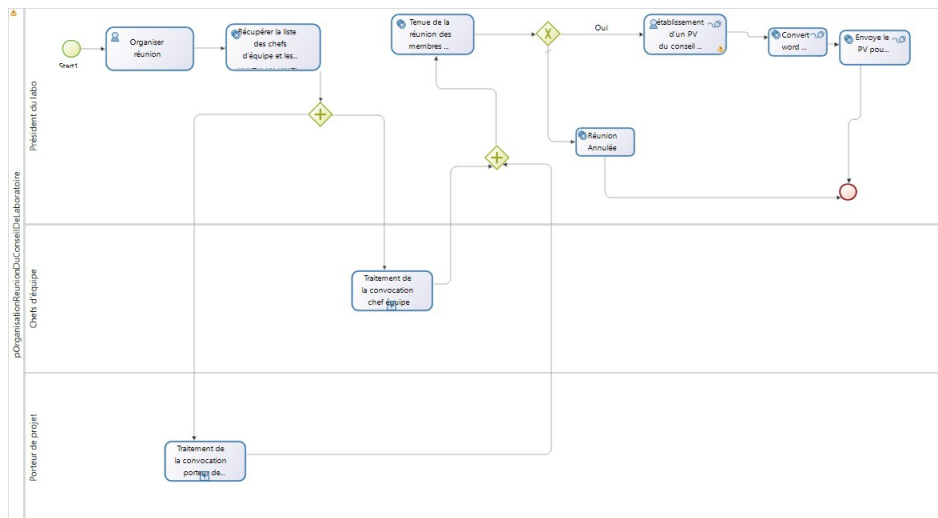


Figure 4.9: Model for Process8

This process "Process8" is a call process that is called from a call activity in a parent process.

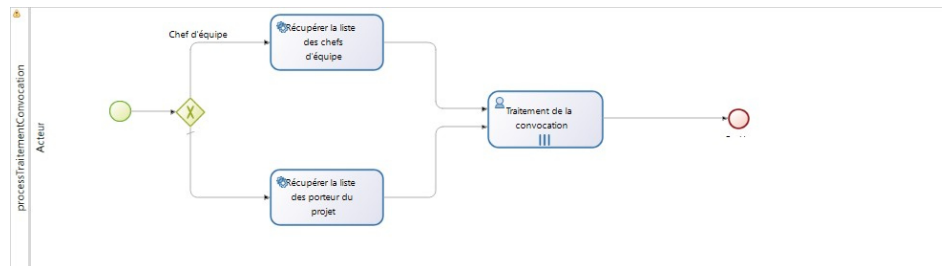


Figure 4.10: Process8

Conclusion

This chapter offered an extensive overview of the activities conducted by the "L'INFI" laboratory. It covered various aspects such as the members of the laboratory, its internal organization, assigned tasks, and the processes involved. In addition, we have provided a detailed description of the different activities within the processes and the actors who participate in each activity. To visually represent our process, we utilized Bonita, a graphical modeling tool. By employing this tool, we were able to create a graphical representation of our process, capturing the various activities and actors involved.

With the completion of the process modeling phase, we are now ready to proceed to the next chapter, where our main objective is to generate a workflow application. To accomplish this, we will utilize the open-source BONITA software. This software will enable us to design and implement our workflow application based on the process model we have created.

Chapter 5

Experimentation And Results

Introduction

After having modeled our process with the BPMN method, we will begin the realization of our application. The purpose of this step is to create a workflow application that we can implement and that will allow us to fully understand the functionalities of workflows. For this, we will use the Open Source tool Bonita as a solution dedicated to the automation of simple and powerful business processes.

Experimentation

Creation of New organization

An organization is a collection of users, usually defined in a hierarchical structure aligned with the structure of the business entity to which the users belong. These hierarchical units can be used as groups within the Bonita organization.[4]

- Definition of the organization.

On the menu click on "Organization -> Define".

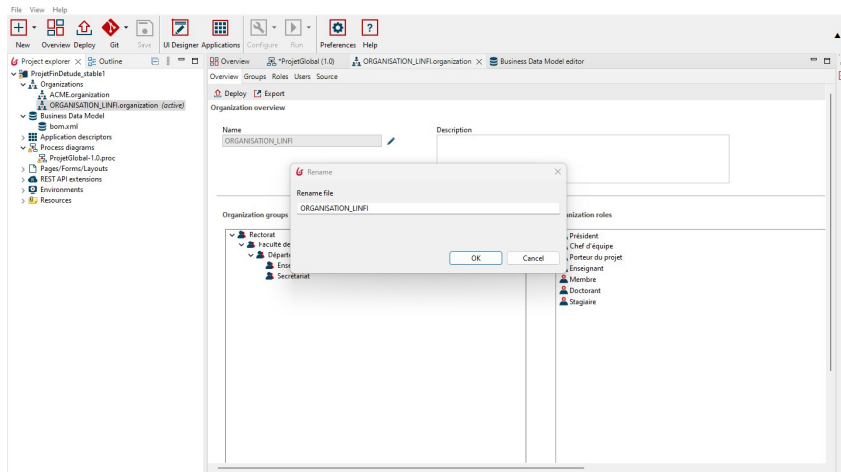


Figure 5.1: Definition of the organization.

- Adds the groups :

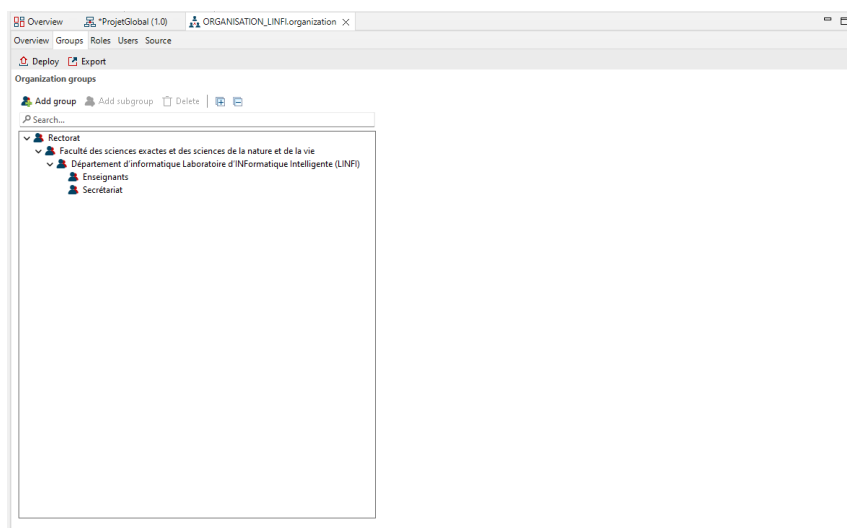


Figure 5.2: Adding groups.

- Add the roles :

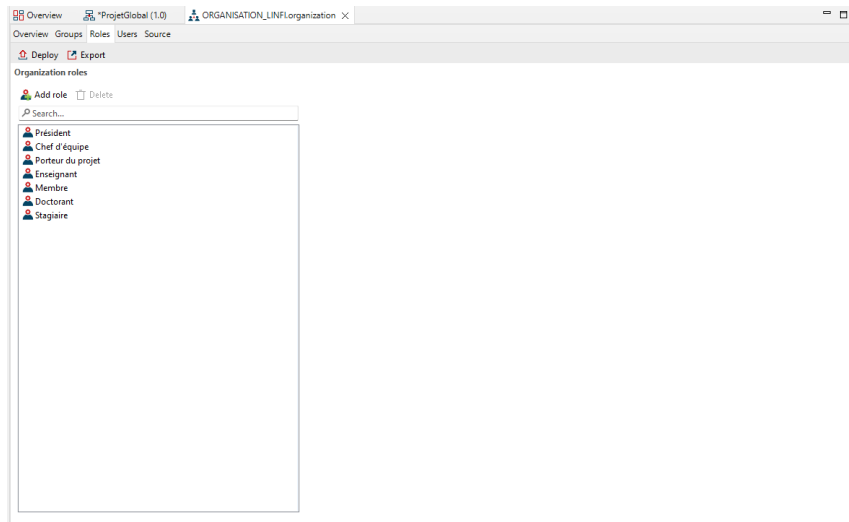


Figure 5.3: Add roles.

- Adds the users :

We add the users while specifying: their name, first name, and password ...

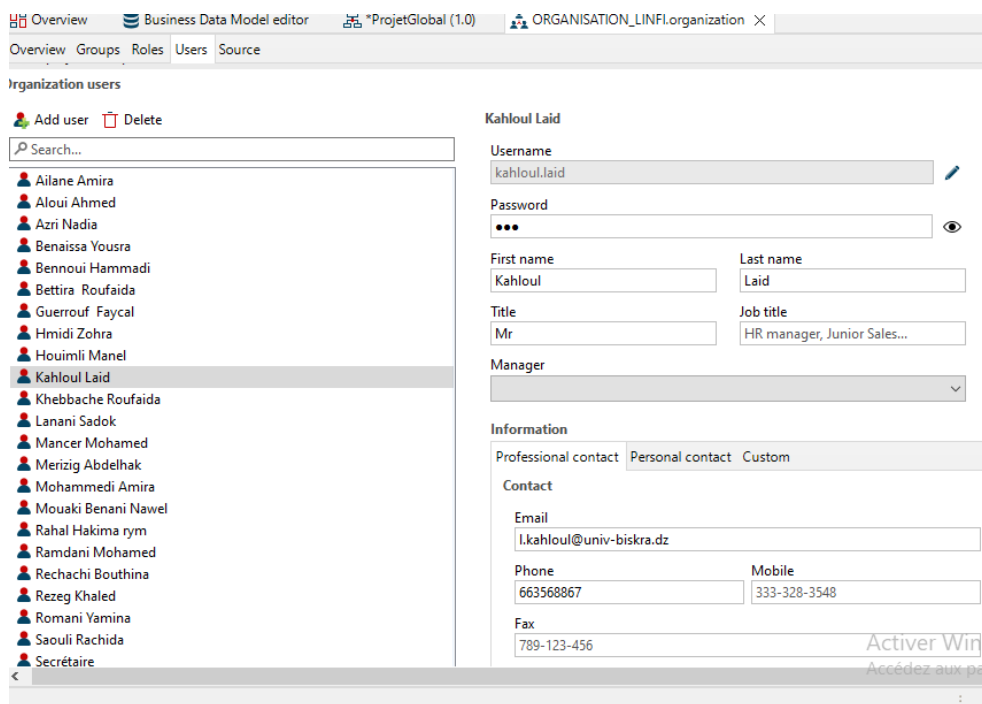


Figure 5.4: Adding users.

Creation of new diagram

- To create a new diagram, we have chosen a design than a new project, and the view appeared as follows:

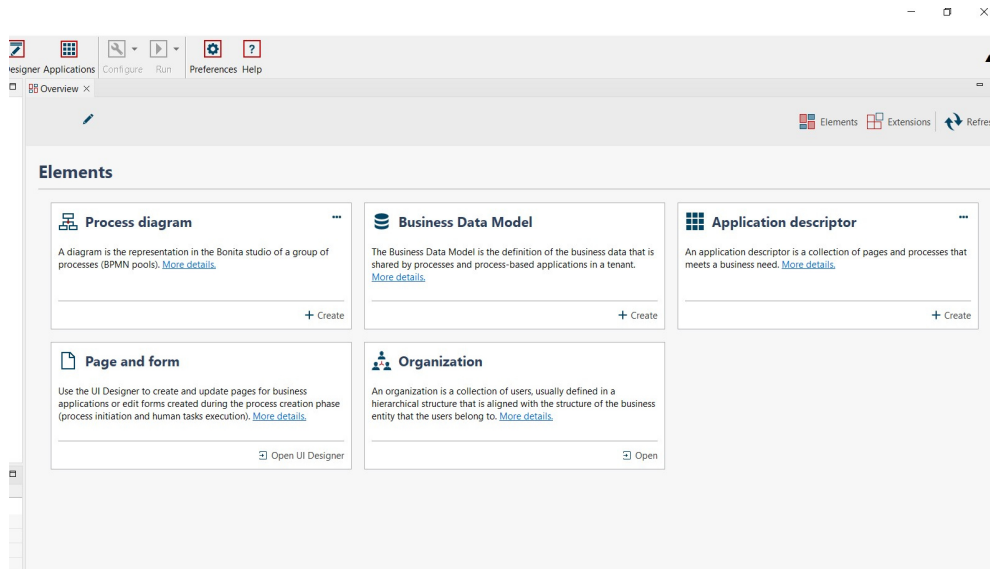


Figure 5.5: BonitaStudio

- Then we have chosen diagrams, we selected (my diagram):

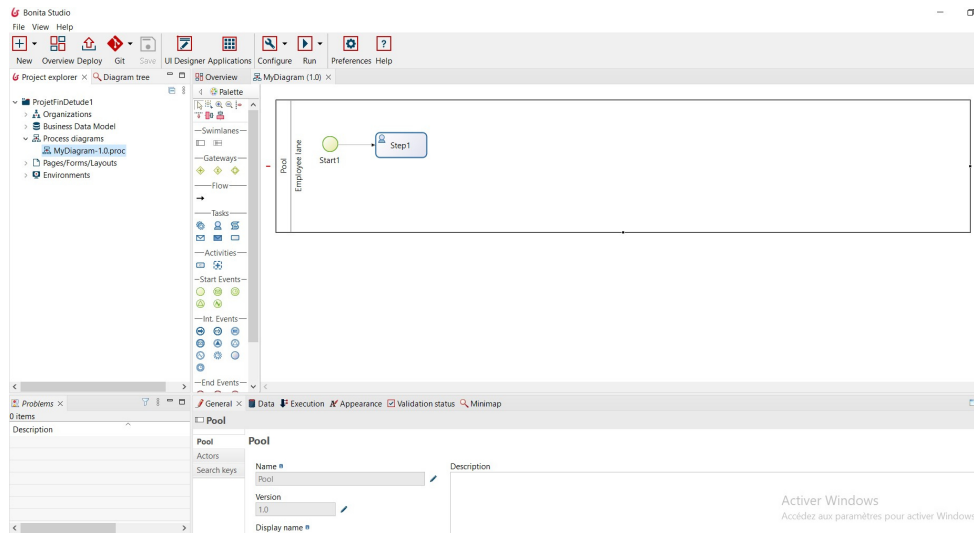


Figure 5.6: First screen in the project.

- And then we selected the elements palette :

Through this tool, you could select the different elements to draw a diagram.

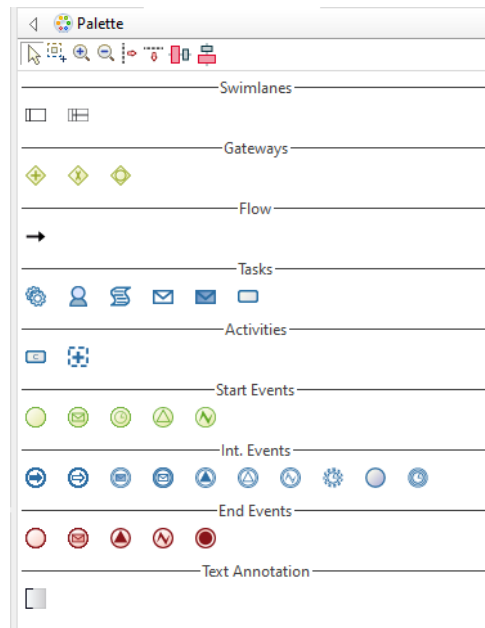


Figure 5.7: Elements palette

When we create a diagram it contains one or more pools, which contain one or more lanes.

For a pool, we can configure the following:

- Name, description, and version number: This information identifies the pool.
- Actors: An actor represents the user who will carry out tasks in the pool.
- Data: A variable is a container for data used in the process.
- Connectors: A connector links a process to an external information source.
- Documents attached to the process: we can attach documents to a process.

For a lane, you can configure the following:

- Name and description.
- Actors: From the actors defined for the pool.
- Data: Define the variables needed in the lane. we can also define variables as task level.

- Connectors: Specify the connectors used in the lane. we can also specify a connector at the task level.
- Documents: Define the documents that are attached to the process.

Definition of the business data model (BDM)

On the menu, after clicking on "Development->Business data model->define" in order to create business objects.

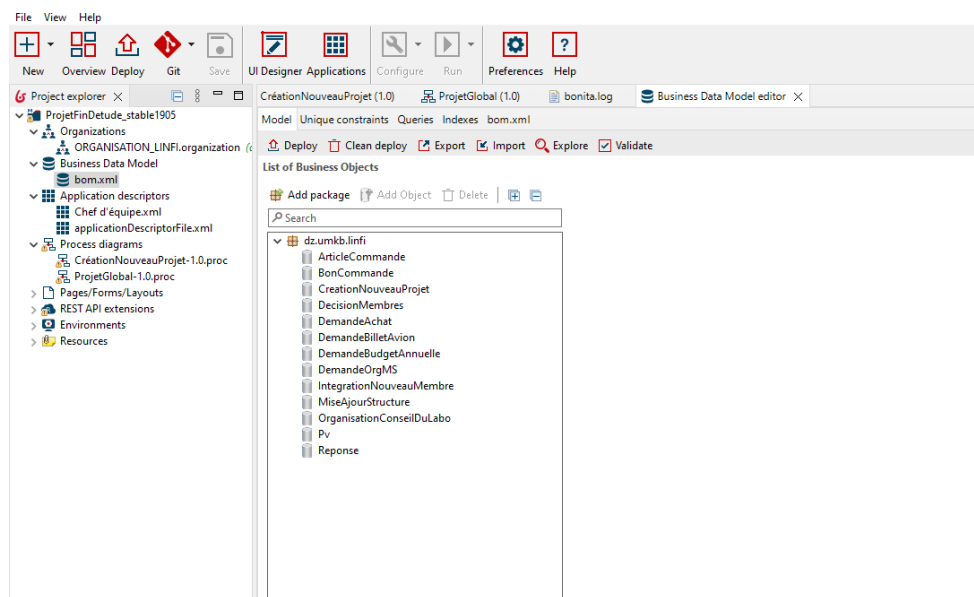


Figure 5.8: Business data model .

Add Business Variables:

Firstly we selected the pool and then on the menu below, clicked on "Execution -> Contract -> Add from business data" and we added the specific data for linking the processes with BDM.

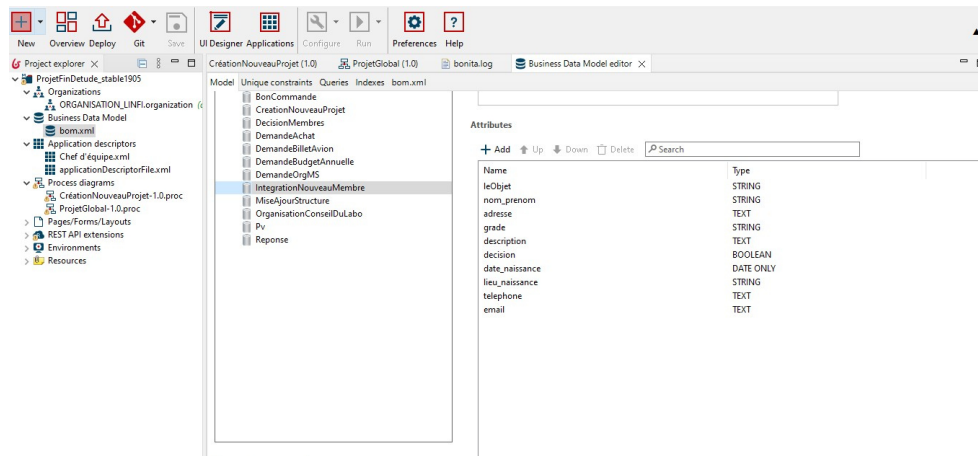


Figure 5.9: Adding data and attributes.

GraphQL schema

GraphQL Voyager is a graphical interface that provides a visual representation of the GraphQL schema. Bonita specifically focuses on the Business Data Model, which represents the structured data used in the processes and applications developed.

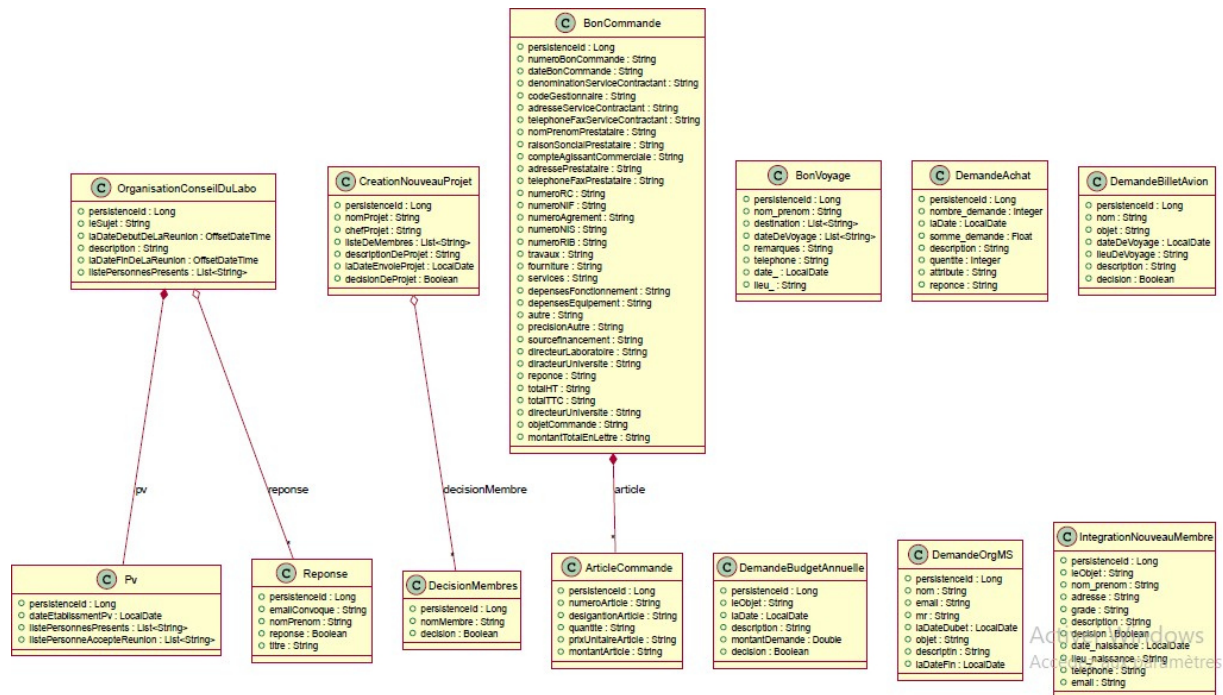


Figure 5.10: GraphQL schema.

Definition of contracts

Contract:

The notion of the contract is available at two levels: process instantiation and human task execution. A contract is composed of inputs and constraints. Inputs are pieces of information that must be provided for the process or the human task. The constraints are applied to the input to check that the values of the inputs are valid. It means that it links the processes and the BDM.

- Select the pool and then on the menu below click on "Execution -> Contract -> Add from business data" and add the specific data.

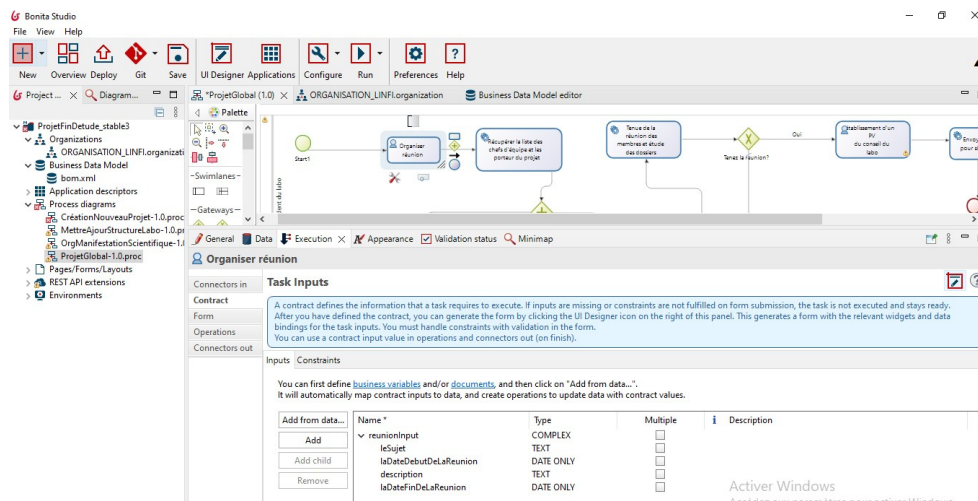


Figure 5.11: Define Contract.

Connectors used

Generate a Word File :

Here we have used the "Template connector" to generate a Word file.

- The insert data in a .docx/.odt template fills a specified template file by inserting values coming from the current process instance.
- The template is a LibreOffice / OpenOffice .odt file or a Microsoft Word.docx file with special placeholders called keys. here we used Microsoft Word.
- A key is a replaceable element in the template that is identified with a dollar sign and surrounded by braces, (eg. \${nom}).
- insert keys in a template file.
 1. Insertion > QuickPart > Champ.
 2. Select ChampFusion (or MergeField in some Word and use a template) as a field name (eg: \${name}, \${user.Name}... etc
 3. Click OK.

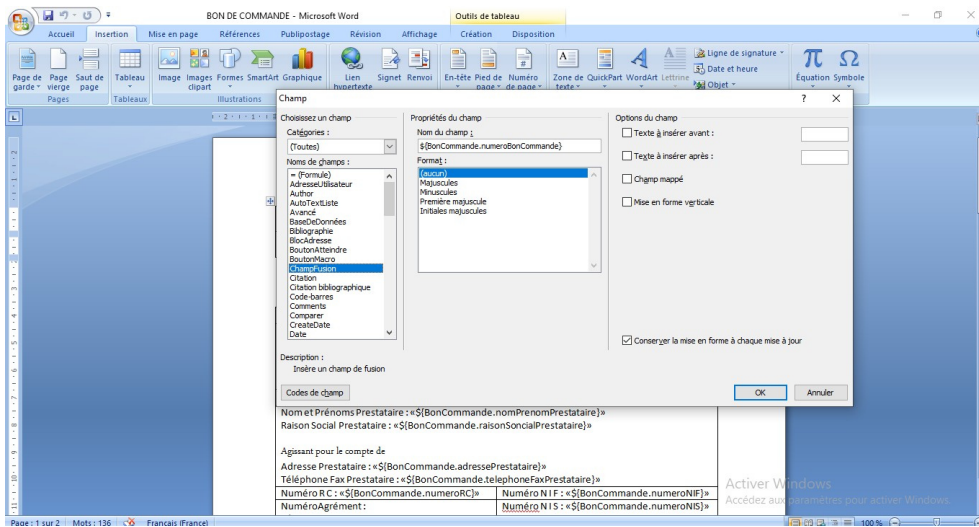


Figure 5.12: insert keys in a template file.

This is an example :

BON DE COMMANDE	
Numéro Bon Commande : «\${BONCommande.numeroBonCommande}»	Date :«\${BONCommande.dateBonCommande}»
Identification de service contractant	
Dénomination Service Contractant : «\${BONCommande.denominationServiceContrac}	
Code Gestionnaire :«\${BONCommande.codeGestionnaire}»	
Adresse Service Contractant : «\${BONCommande.adresseServiceContractant}»	
Téléphone Fax Service Contractant: «\${BONCommande.telephoneFaxServiceContrac}	
Identification de Prestataire	
Nom et Prénoms Prestataire : «\${BONCommande.nomPrenomPrestataire}»	
Raison Social Prestataire : «\${BONCommande.raisonSoncialPrestataire}»	
Agissant pour le compte de	
Adresse Prestataire : «\${BONCommande.adressePrestataire}»	
Téléphone Fax Prestataire : «\${BONCommande.telephoneFaxPrestataire}»	
Numéro R.C : «\${BONCommande.numeroRC}»	Numéro N I F : «\${BONCommande.numeroNIF}»
Numéro Agrément : «\${BONCommande.numeroAgrément}»	Numéro N I S : «\${BONCommande.numeroNIS}»
Numéro R I B : «\${BONCommande.numeroRIB}»	
Caractéristique de la commande	
Travaux«\${BONCommande.travaux}»	Dépenses Fonctionnement : «\${BONCommande.depensesFonctionnement}»
Fourniture«\${BONCommande.fourniture}»	Dépenses Equipement : «\${BONCommande.depensesEquipement}»
Services «\${BONCommande.services}»	Autre «\${BONCommande.autre}»

Figure 5.13: Purchase Order Template.

- After we Added a connector to a task (in or out), selected the "Office" category, and then chose "insert data in a.docx/odt template" to configure the connector.

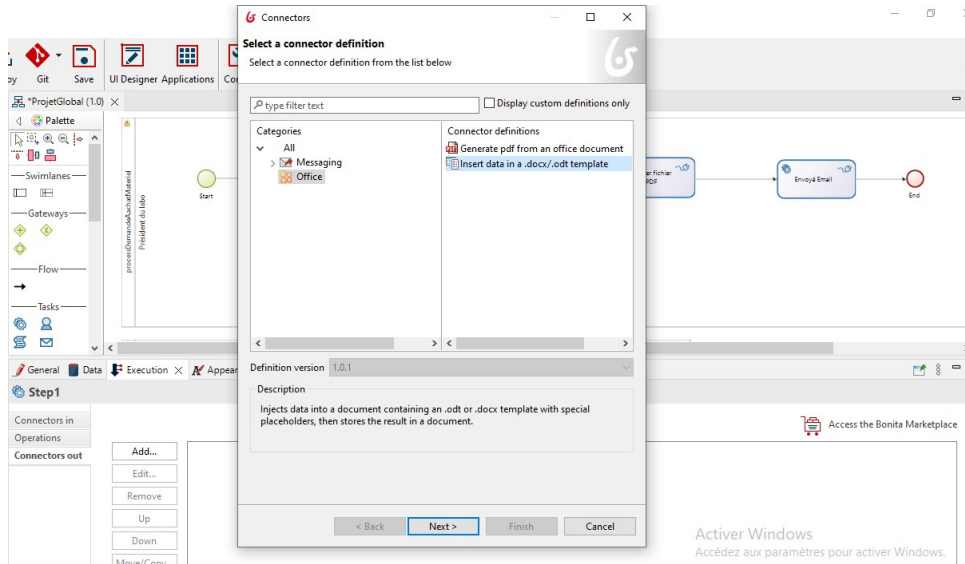


Figure 5.14: Add connector.

- We selected the file containing the template with document placeholders. The keys used in the document are defined by us, and we have defined the expressions used to replace the output keys.

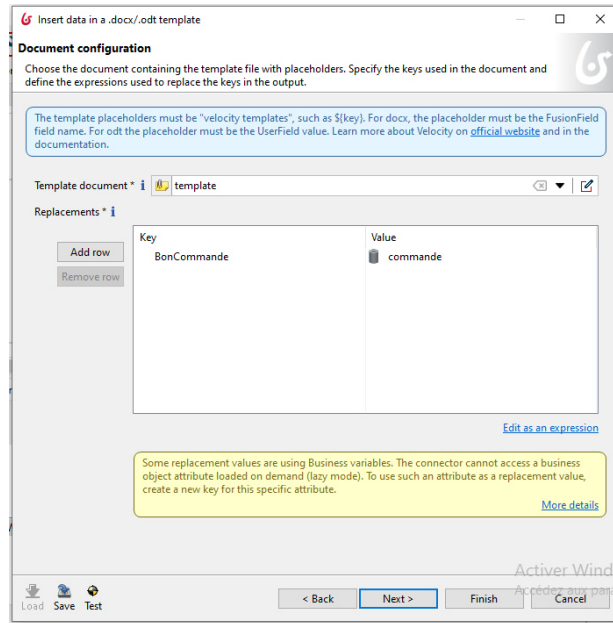


Figure 5.15: Document configuration.

➤ And finally, we defined the output file.

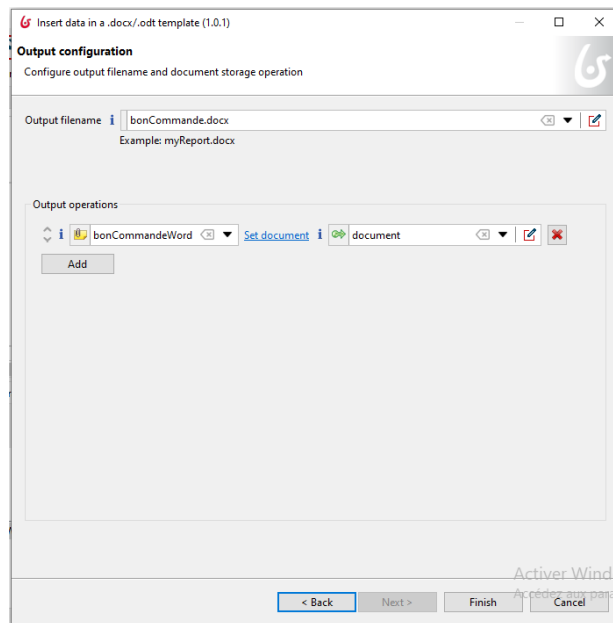


Figure 5.16: Output Configuration.

➤ When the connector runs, it builds a file based on the template and populates the key placeholders with the current values of the necessary variables.

BON DE COMMANDE	
Numero Bon Commande : 120	Date : 29/05/2023
Identification de service contractant	
Dénomination Service Contractant : abcd	
Code Gestionnaire : abcdf	
Adresse Service Contractant : biskra-biskra	
Téléphone Fax Service Contractant: 02325665	
Identification de Prestataire	
Nom et Prénoms Prestataire : mounahadjer	
Raison Social Prestataire : azert	
Agissant pour le compte de	
Adresse Prestataire : biskra	
Téléphone Fax Prestataire : 030303	
Numero R.C : 03	Numero N.I.F : 02
Numero Agrément : 012	Numero N.I.S : 21
Numero R.I.B : 23	
Caractéristique de la commande	
Travaux Non	Dépenses Fonctionnement : Non
Fourniture Oui	Dépenses Equipement : Non
Services Non	Autre Non

Act
Accé

Page 1 / 2 — 🔍 +

Figure 5.17: Purchase order.

Generate PDF File

- We generated a PDF file by converting a document from .odt or .docx format to PDF.

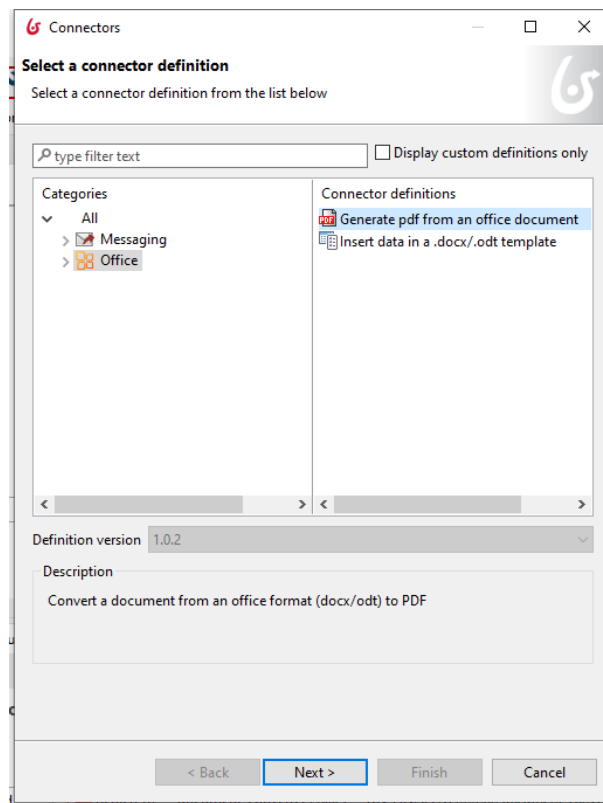


Figure 5.18: Select a connector definition.

- After we collected or retrieved the source document from the user or a storage location.
- Determining the character encoding of the source document.

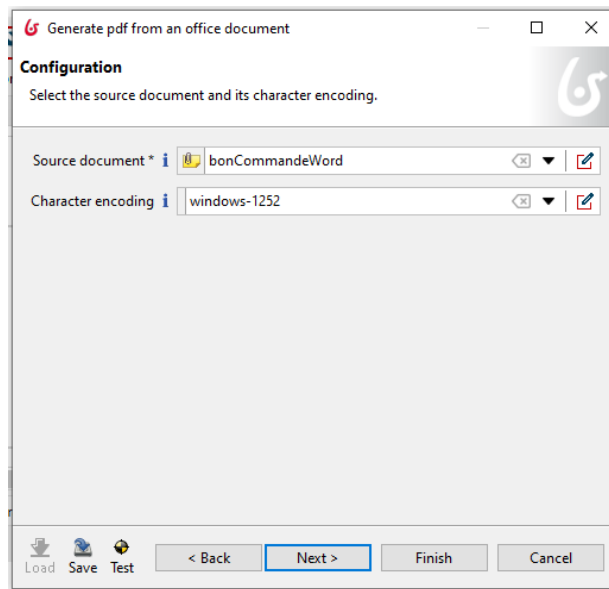


Figure 5.19: Configuration.

➤ Configure output file name and document storage operation

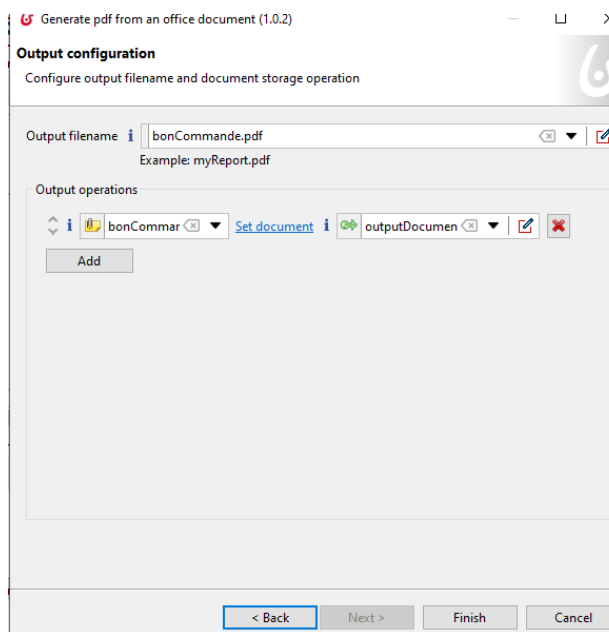


Figure 5.20: Output configuration.

Send an Email

The Connector Email feature allows us to integrate email communication within our business processes. We have used it in all our processes.

- Email configuration:

To enable Bonita Studio to send emails, we needed to configure the email settings.

Here's how we could do it:

- * You define the following parameter values:

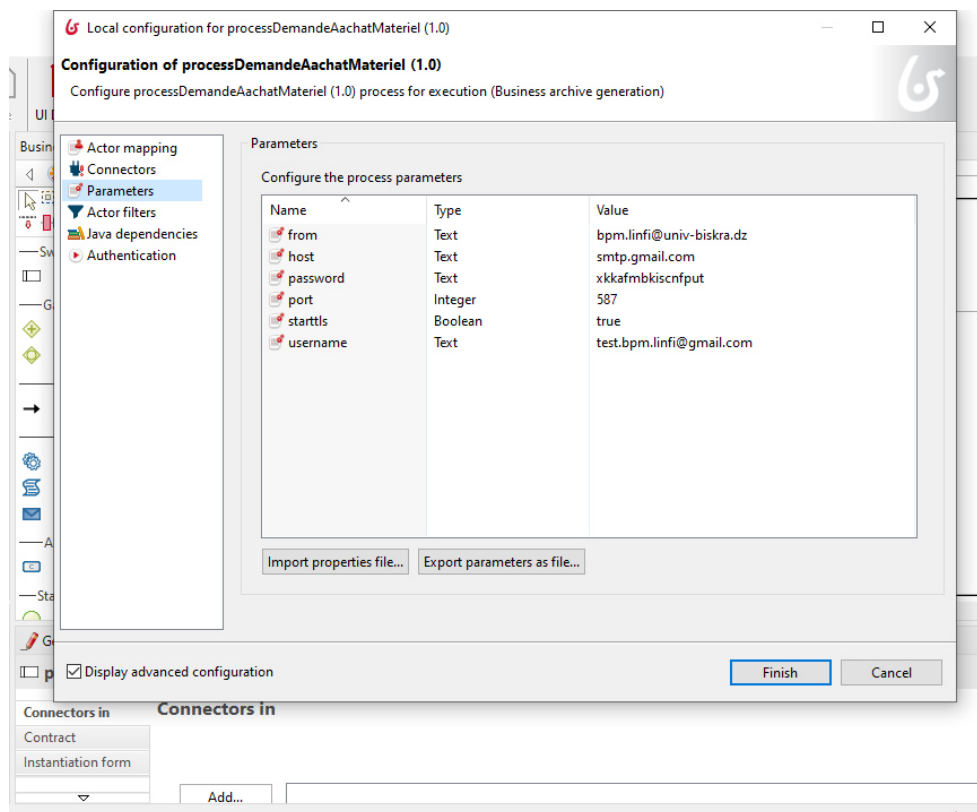


Figure 5.21: Step 1 of the procedure.

- * Go to Execution -> Connectors out.
- * Click on Add.
- * Select the Email (SMTP) connector.
- * Name the connector configuration.

- * We set the following parameter values :
 - **SMTP Server:** We entered our SMTP server address.
 - **SSL (in the Security section):** unchecked.
 - **Port:** We specify the port number of the SMTP server.
 - **Username :** We entered the username.
 - **Password:** We entered the password to authenticate the SMTP server.
 - Click on **Next**.

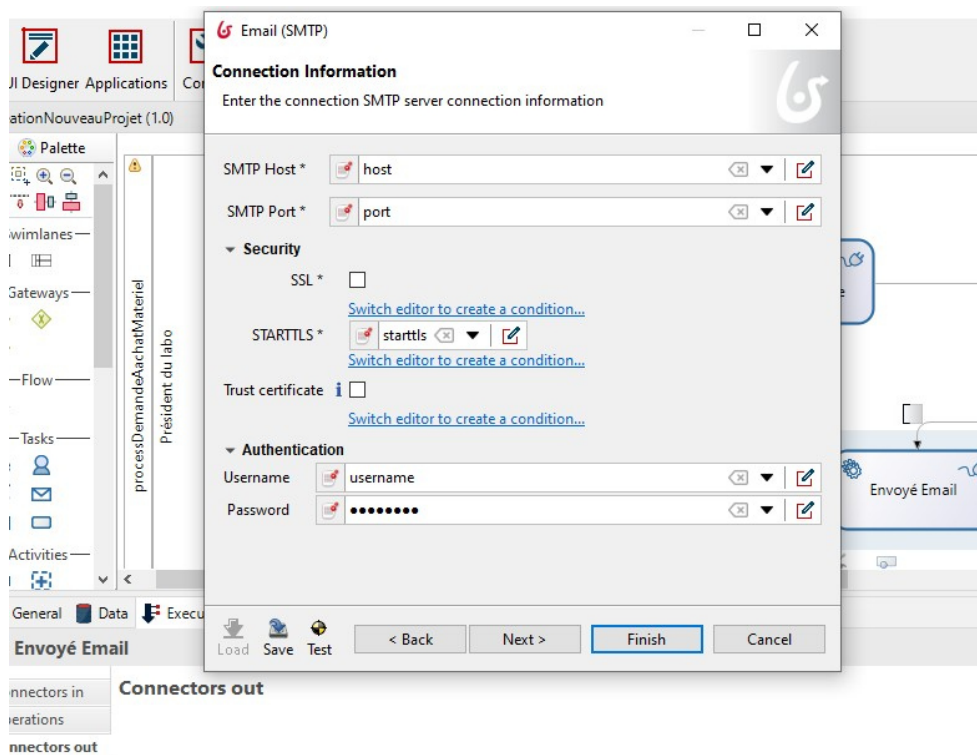


Figure 5.22: Step 2 of the procedure.

- * **From:** Specify the email address from which the emails will be sent.
- * Use the pencil icon to edit the expression of the **To** field.
- * Click on **Next**.

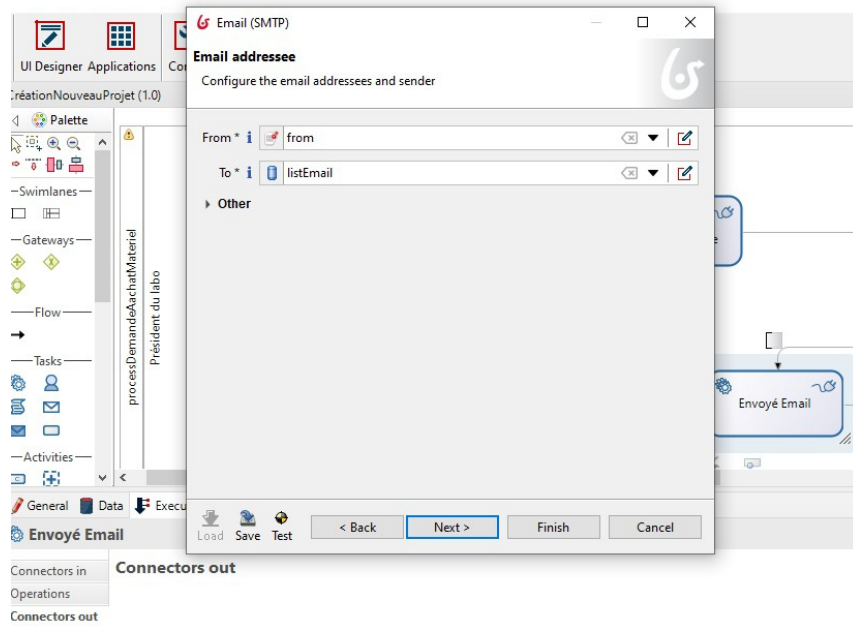


Figure 5.23: Step 3 of the procedure.

- * Set the Expression type to Script.
- * Click on **Finish**.

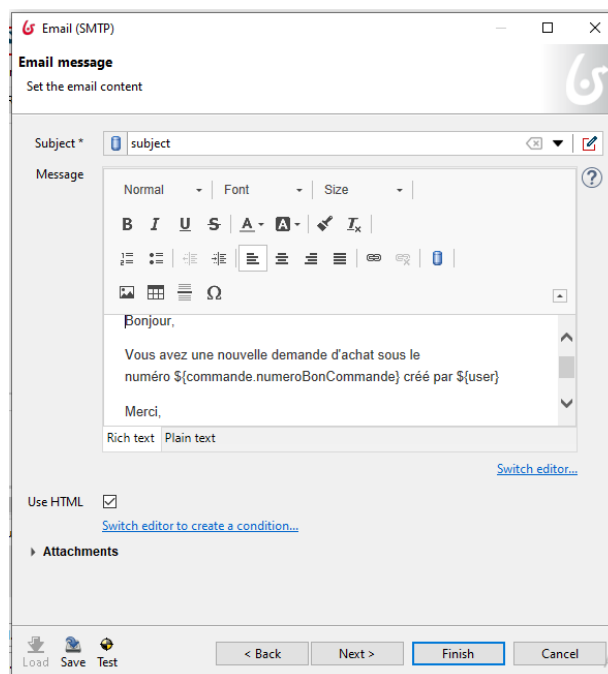


Figure 5.24: Step 4 of the procedure.

Create and modify User Interfaces

- Select the task and go to "Execution->contract", click on the small icon on the top right to generate the form automatically, it contains all the fields for each This form contains all the fields for each attribute defined in the business model and then we click on the button save data.

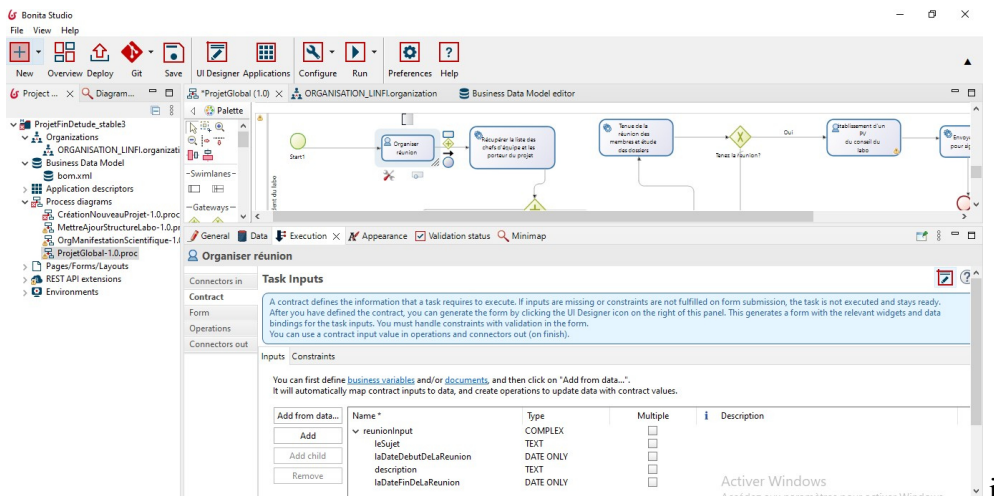


Figure 5.25: Creation of forms

- Modification of the Form from Bonita's UI editor.

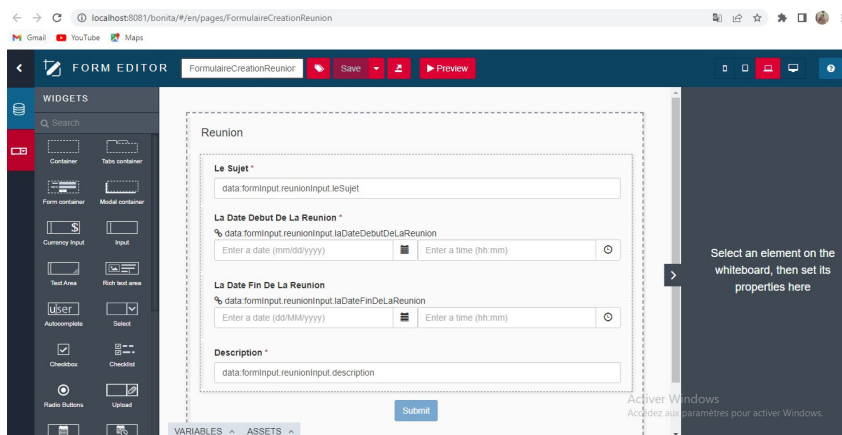


Figure 5.26: Form to create a reunion.

Using APIs:

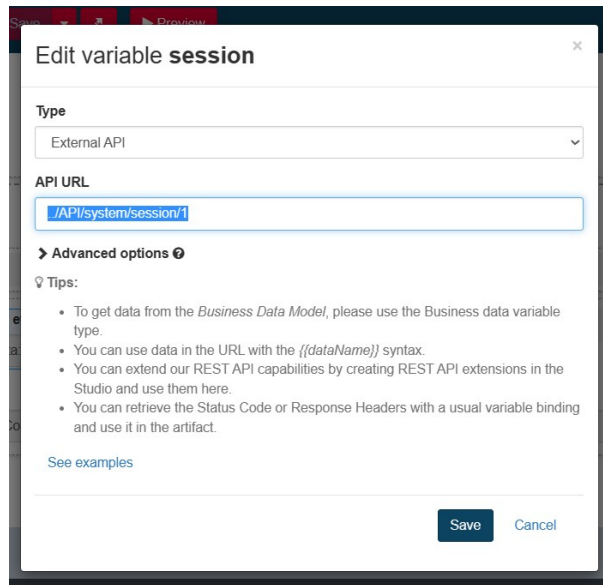
To maximize automation it is necessary to retrieve data from the logged-in user (to reduce user input), here we have integrated our application with the Bonita solution using the REST Web API, to enable us to access data from HTTP requests, it is useful when implementing web forms/pages for a good user experience.

The screenshot displays a form editor interface. At the top, there is a header with the placeholder `{{ task.displayName }}` and a description `{{ task.displayDescription }}`. Below this is a section labeled "Reponse" containing a form with several input fields. One field is labeled "Titre" with the value "Nom et prénom" and another is labeled "Email convoqué". At the bottom of the form are two buttons: "Refusé" (red) and "Accepter" (green). Below the form is a "VARIABLES" panel with a search bar and a table of variables.

Name	Value	Type
organisationConseilDuLabo_selected		String
session	./API/system/session/1	External API
setUserDetails	<code>\$data formInput.reponse nomPrenom = \$data userDetails.lastname + " " + \$data.user...</code>	Javascript expression
submit_errors_list	<code>!(\$data formOutput && \$data formOutput _submitError && \$data formOutput _submit...</code>	Javascript expression

Figure 5.27: A Form using the API

- Firstly, create a new variable of type "**External API**". This "**Login API**": Logs into the engine in a platform and creates a session. A session is a context in which processing occurs and is created when a user logs in to the Engine. The APIs remain available for the duration of a session.



Edit variable session

Type
External API

API URL
/API/system/session/1

Advanced options

Tips:

- To get data from the *Business Data Model*, please use the Business data variable type.
- You can use data in the URL with the `{{dataName}}` syntax.
- You can extend our REST API capabilities by creating REST API extensions in the Studio and use them here.
- You can retrieve the Status Code or Response Headers with a usual variable binding and use it in the artifact.

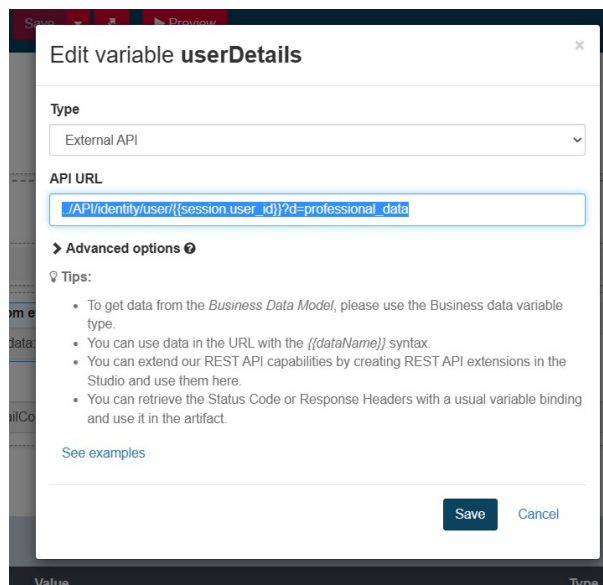
[See examples](#)

Save Cancel

Figure 5.28: An API session

- Then, create another variable of type **"External API"**.

This retrieves a user's professional data based on the session's **"userId"**, which is used to specify the professional data.



Edit variable userDetails

Type
External API

API URL
/API/identity/user/{{session.user_id}}?d=professional_data

Advanced options

Tips:

- To get data from the *Business Data Model*, please use the Business data variable type.
- You can use data in the URL with the `{{dataName}}` syntax.
- You can extend our REST API capabilities by creating REST API extensions in the Studio and use them here.
- You can retrieve the Status Code or Response Headers with a usual variable binding and use it in the artifact.

[See examples](#)

Save Cancel

Figure 5.29: Professional Data

- Finally, to retrieve the user's data and display it in the connected user's form, we used

a "javascript" variable.

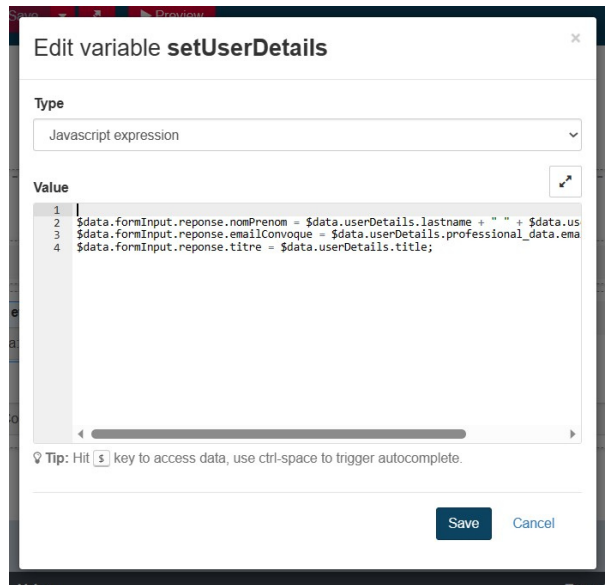


Figure 5.30: Javascript variables.

- This is the form after using the API.

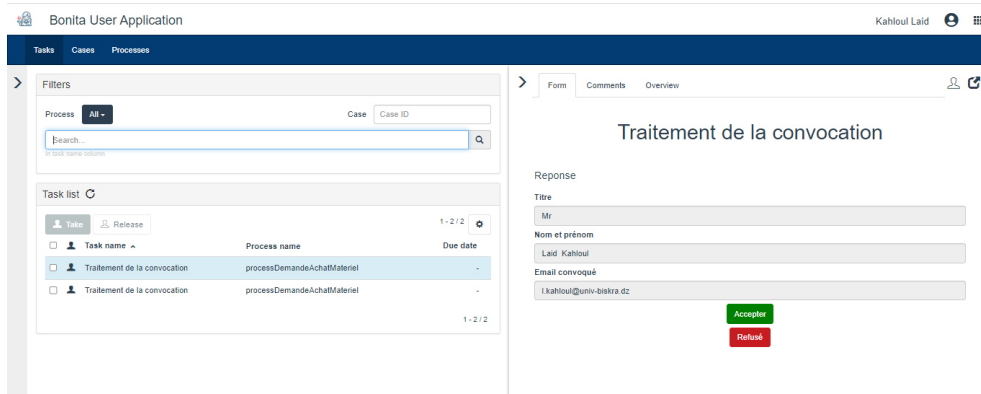


Figure 5.31: The Form After Using The APIs.

Creation of the application

An application descriptor:

An application file is an XML file containing one or more application descriptors. It represents the skeleton of an application, as it contains references to resources installed in the Bonita platform and used by a given application.

To create an application go to the menu, then click on "Development->Application description->new".

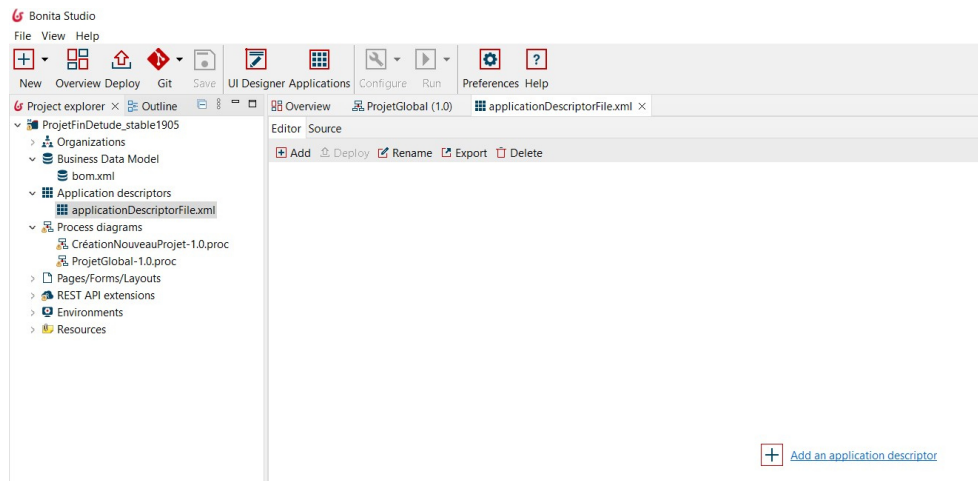


Figure 5.32: Creation Of Application Descriptor.

Select " Add an application descriptor ", Here give a name to the application.

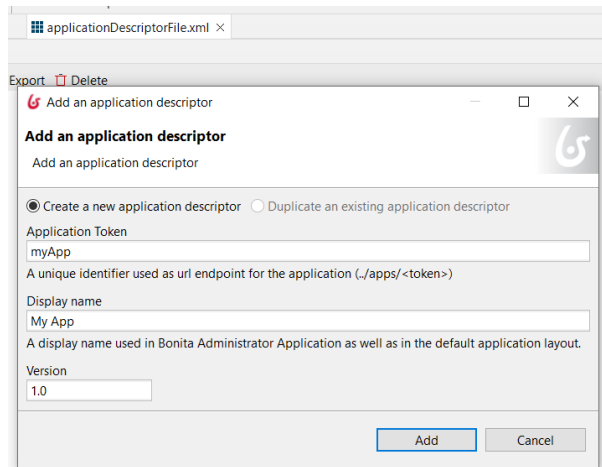


Figure 5.33: Label your application.

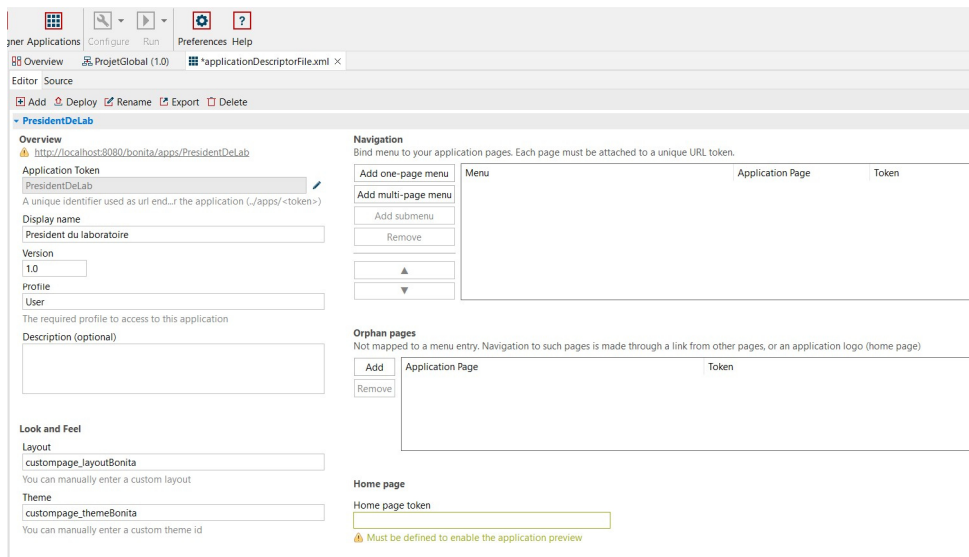


Figure 5.34: Creation Of Application Descriptor.

Here we add the "Process List" and "Tasks List".

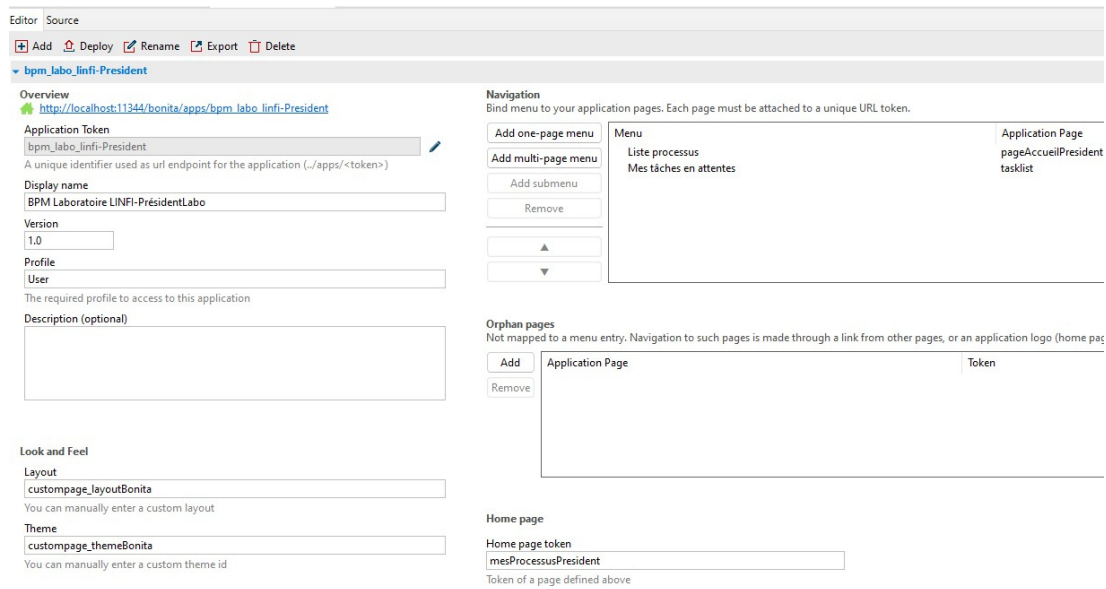


Figure 5.35: Description Of Application.

Add pages to the application

- To create the perfect user experience for different profiles of applications user, you need to create custom pages. This can be done with Bonita's UI Designer.

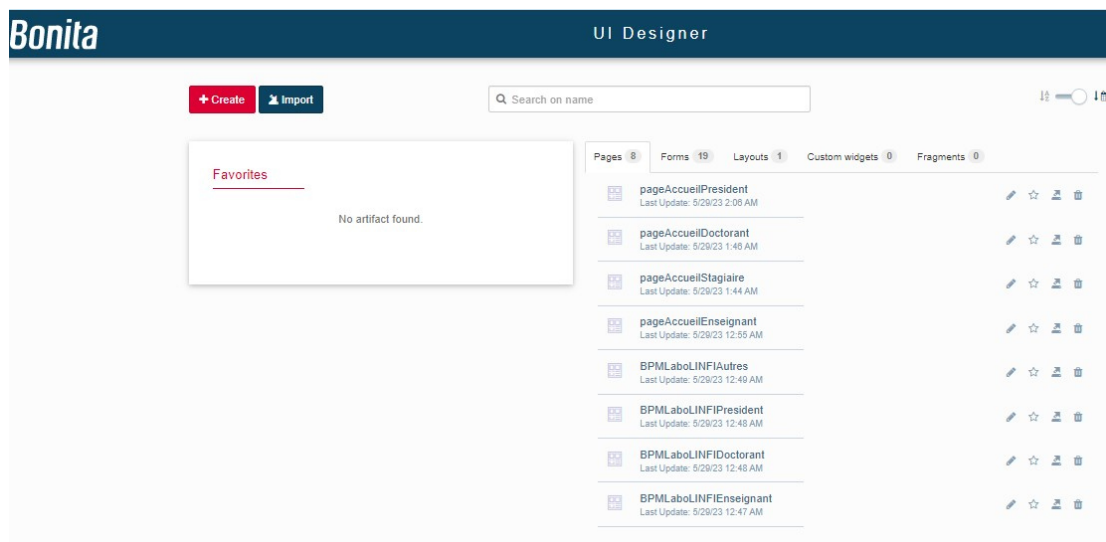


Figure 5.36: Purchase of laboratory equipment.

- Here we add processes that can be started by the user:

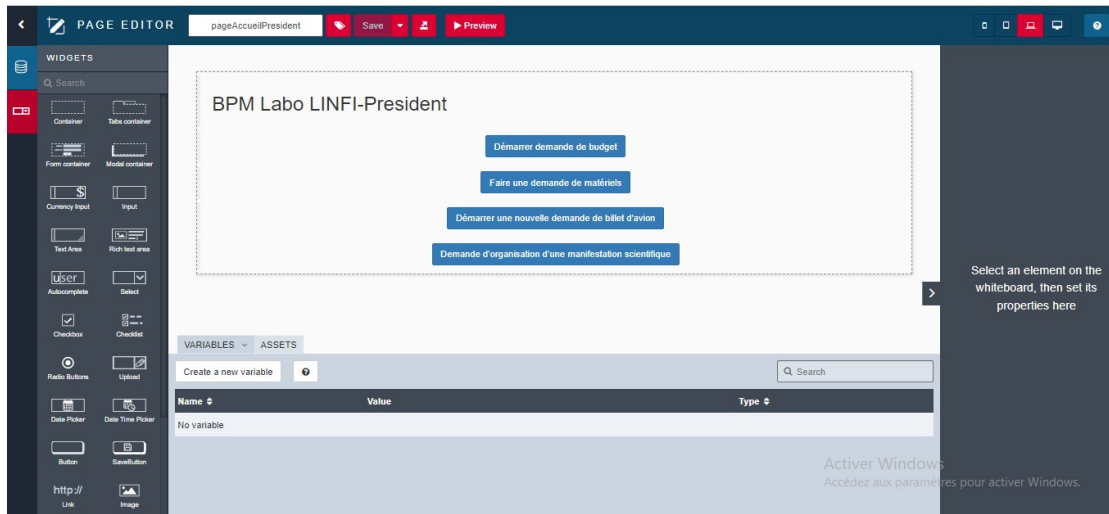


Figure 5.37: President home page.

- Access as Administrator.

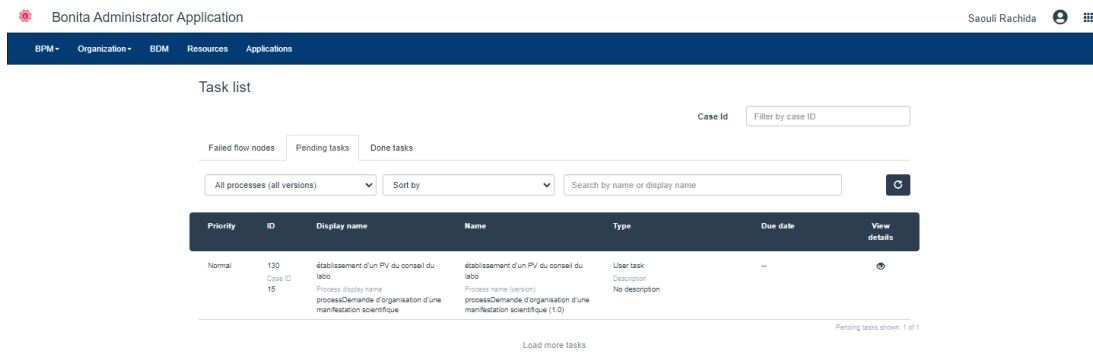


Figure 5.38: Administrator Interface.

Presentation of our Application

To access the application: through the Bonita BPM portal, the user can access this interface below by entering his username and password.

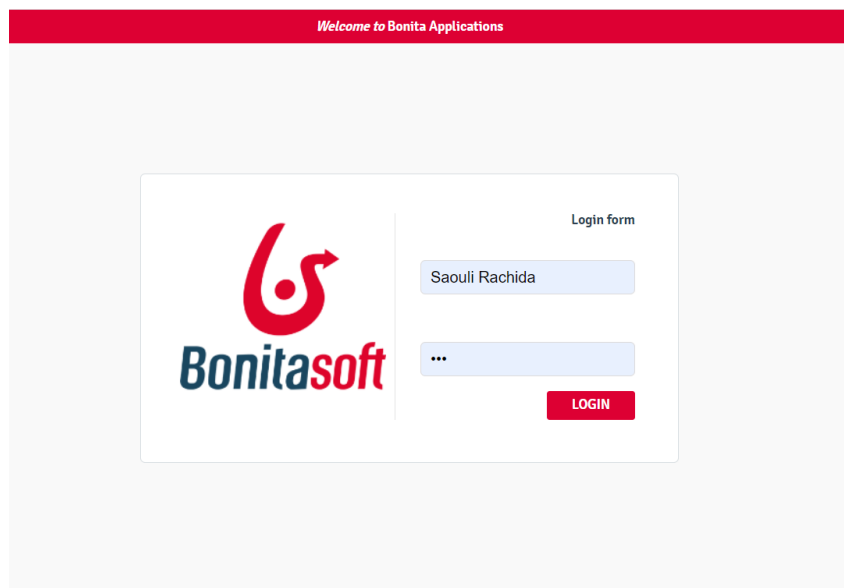


Figure 5.39: The Bonita BPM portal.

- This is the applications list.

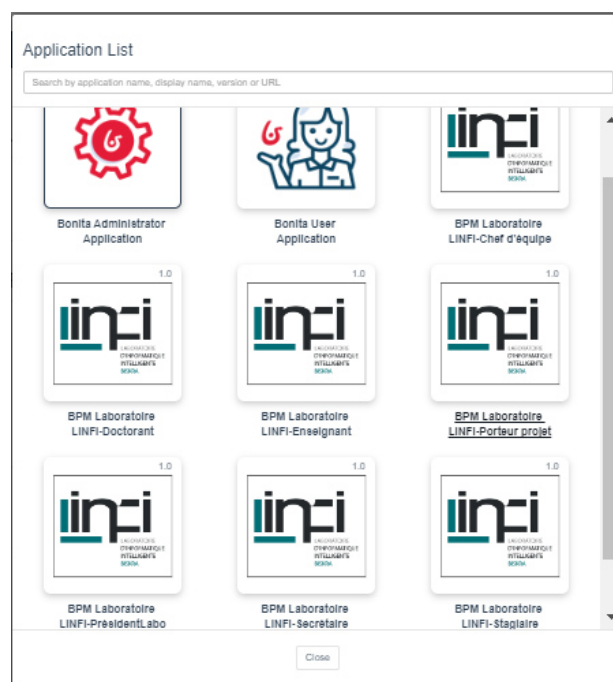


Figure 5.40: Applications list.

1. Lab president application :

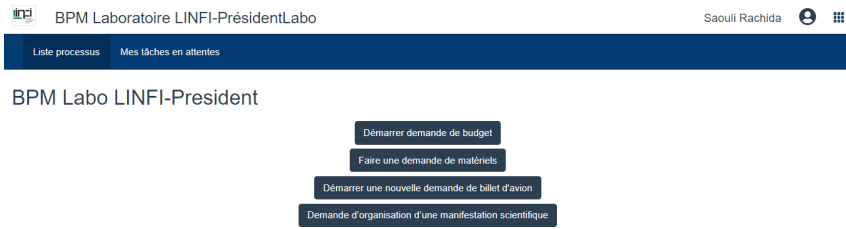


Figure 5.41: Lab President's Application.

2. Teacher application interface:



Figure 5.42: Teacher application.

3. PhD Student application interface :

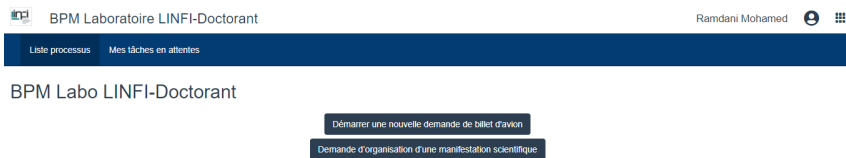


Figure 5.43: PhD Student application

4. Trainee application interface:



Figure 5.44: Trainee application.

5. Secretary application interface :

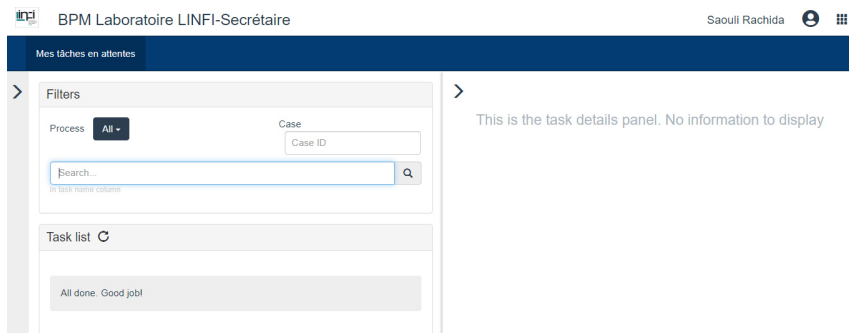


Figure 5.45: Lab President's Application.

6. Team leader application interface :

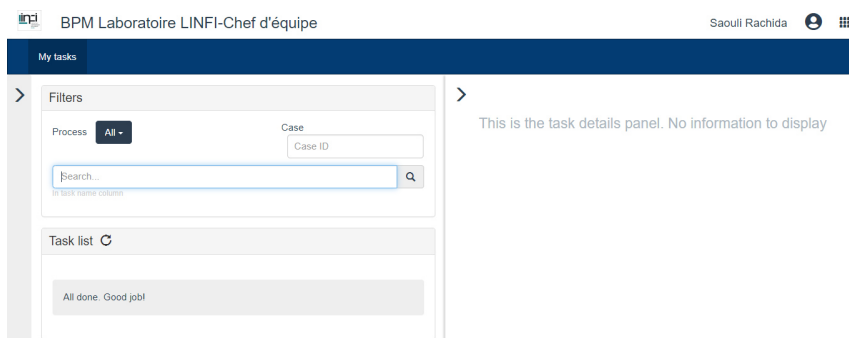


Figure 5.46: Team leader application.

7. Project holder application interface :

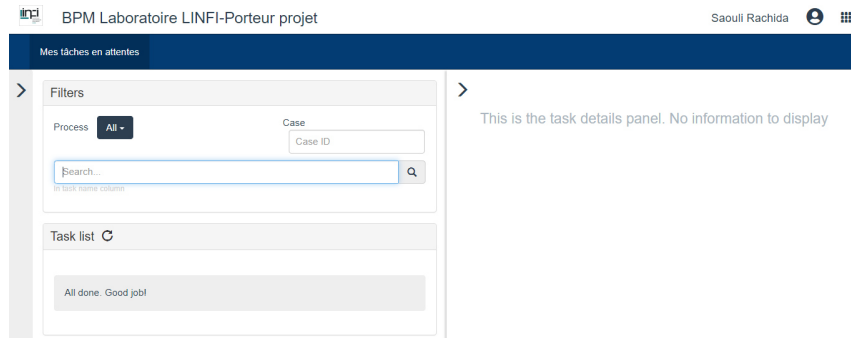


Figure 5.47: Project holder application.

- This is the forms list.

Figure 5.48: New project creation form .

Faculté : SESNV كلية : العلوم الدقيقة و علوم الطبيعة و الحياة

Département : Informatique قسم : الاعلام الالي

Laboratoire de Recherche : LINFI مخبر البحث: المعلوماتية الذكية

Demande Budget Annuelle

Le Objet *

La Date *

Enter a date (mm/dd/yyyy) Today

Description

H1 H2 H3 H4 H5 H6 P B I U pre

Words: 0 Characters: 0

Montant demandé

0

[Submit](#)

Figure 5.49: Budget request form .

الجمهورية الجزائرية الديمقراطية الشعبية
République Algérienne Démocratique et Populaire
وزارة التعليم العالي والبحث العلمي
Ministère de l'enseignement supérieur et de la recherche scientifique

Université Mohamed Khider - Biskra جامعة محمد خيضر - بسكرة

Faculté : SESNV كلية : العلوم الدقيقة و علوم الطبيعة و الحياة

Département : Informatique قسم : الاعلام الالي

Laboratoire de Recherche : LINFI مخبر البحث: المعلوماتية الذكية

Integration Nouveau Membre

Objet Nom et prenom

Grade Adresse

Date de naissance Lieu de naissance

Enter a date (mm/dd/yyyy) Today

Email

Telephone

Description

[Submit](#)

Figure 5.50: Integration request form.

Faculté des sciences exactes et des sciences de la nature et de la vie
 Département d'informatique
 Laboratoire d'INFormatique Intelligente (LINFI)

Demande d'organisation d'une manifestation scientifique

Titre Nom Email

La Date début Today La Date Fin Today

Objet

Descriptif

H1 H2 H3 H4 H5 H6 P B I U S pre

<> Words: 0 Characters: 0

Figure 5.53: Request form for the organization of a scientific event .

الجمهورية الجزائرية الديمقراطية الشعبية
 République Algérienne Démocratique et Populaire
 وزارة التعليم العالي والبحث العلمي
 Ministère de l'enseignement supérieur et de la recherche scientifique

جامعة محمد خيضر - بسكرة
 كلية: العلوم التقنية و علوم الطبيعة و الحياة
 قسم: الاعلام الآلي
 مخزن البحث: المعلوماتية للتكية

Université Mohamed Khider - Biskra
 Faculté : SESNV
 Département : Informatique
 Laboratoire de Recherche : LINFI

Reunion

Le Sujet

La Date Debut De La Reunion *

La Date Fin De La Reunion

Description

Figure 5.54: Meeting creation form.

Figure 5.55: Invitation processing form.

- Now we run the Purchase request process:

Figure 5.56: Purchase request process.

After submitting the request to purchase laboratory equipment, a meeting of the Laboratory Council is organized.

The invitation contains the subject of the meeting, the date, and a description of the meeting.

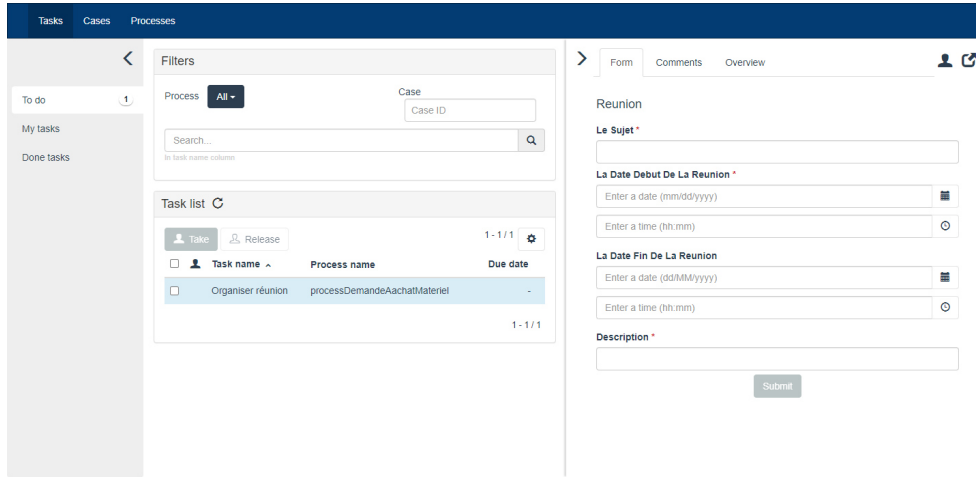


Figure 5.57: Organize meetings.

The laboratory president sends the invitation to team leaders and project leaders. Each team leader and project manager concerned accepts or refuses the invitation to attend.

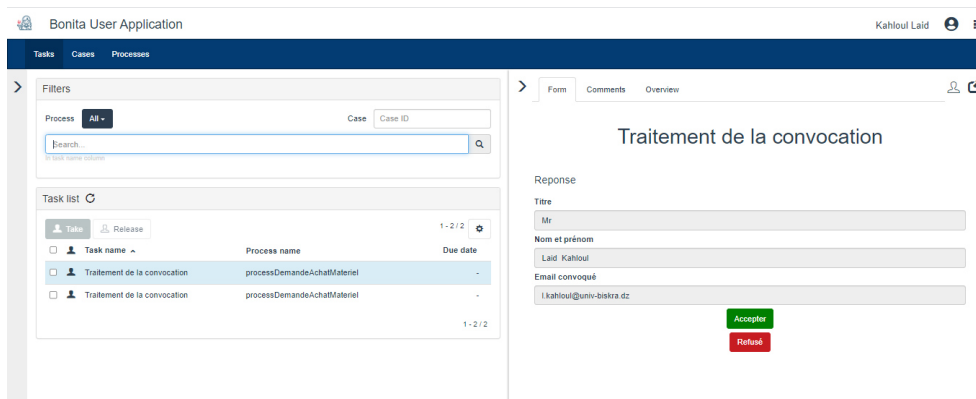


Figure 5.58: interface Call processing by project managers and team leaders.

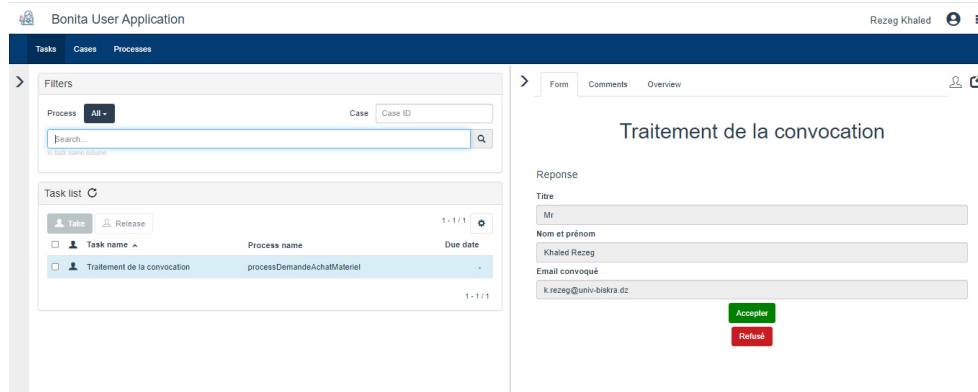


Figure 5.59: interface Call processing by team leaders.

If (number of participants ≥ 4) the lab council meeting is held.

Otherwise (number of participants < 4) the lab council meeting is canceled. If the Laboratory Council approves, a report is drawn up(PV), and sent by e-mail.

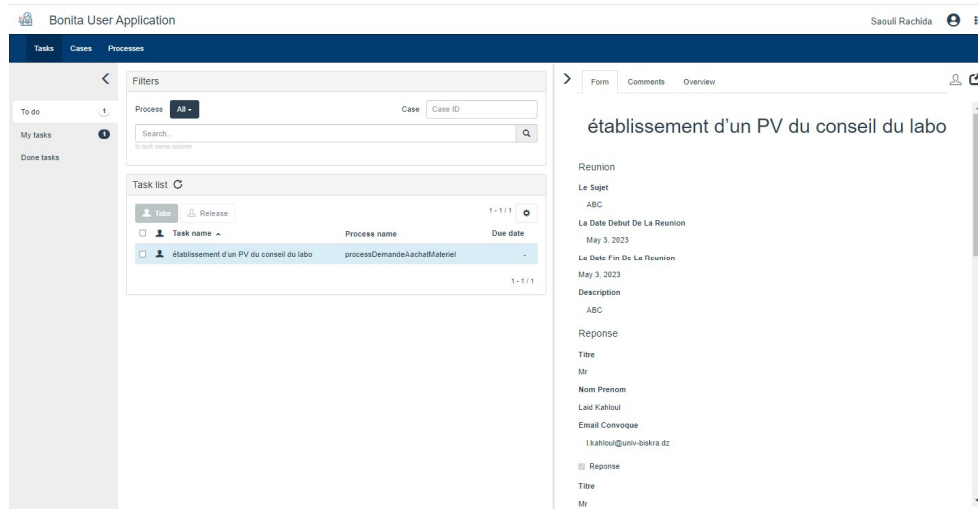


Figure 5.60: interface establishment of a PV of the lab council.

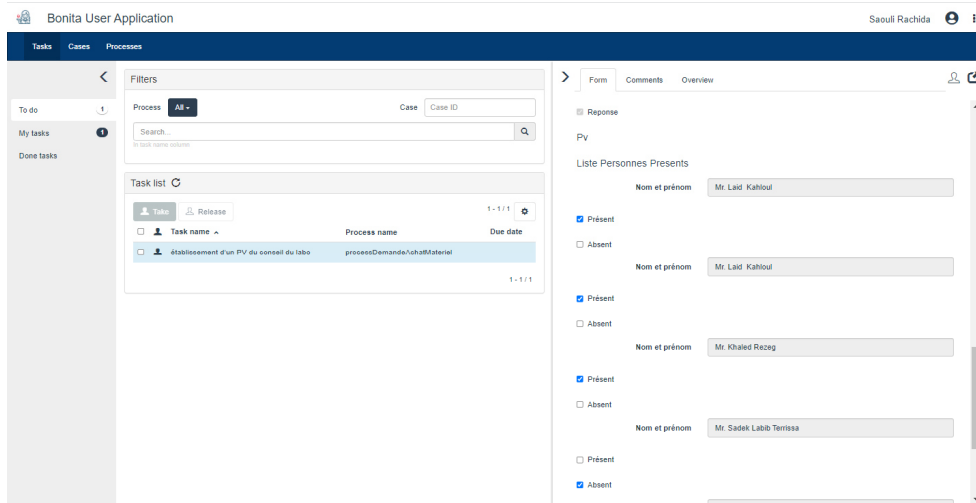


Figure 5.61: list persons present.

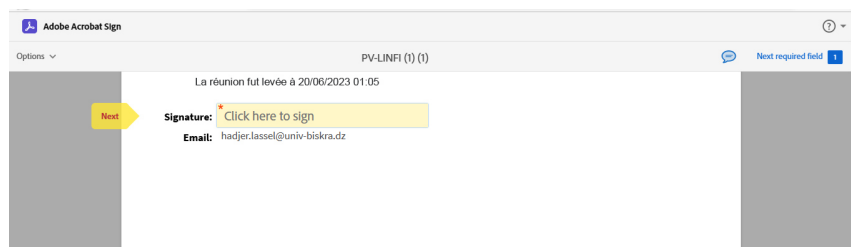


Figure 5.62: Electronic Signature.

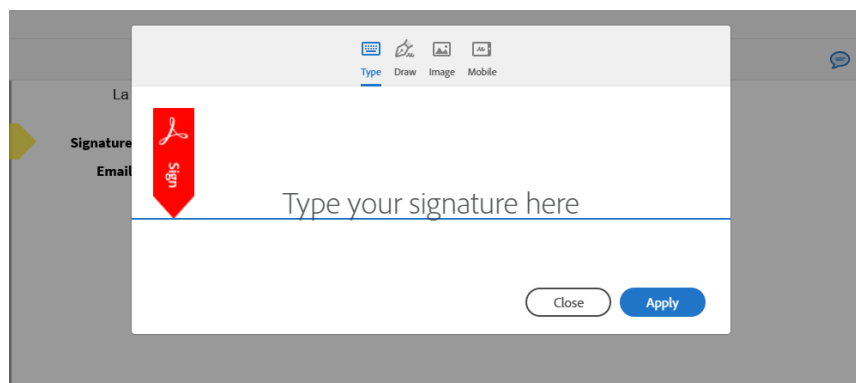


Figure 5.63: Electronic Signature.

La réunion fut levée à 20/06/2023 01:05

Signature: Hadjer
Hadjer (Jun 20, 2023 17:33 GMT+2)

Email: hadjer.lassel@univ-biskra.dz

Figure 5.64: Electronic Signature.

Receive reports by e-mail.

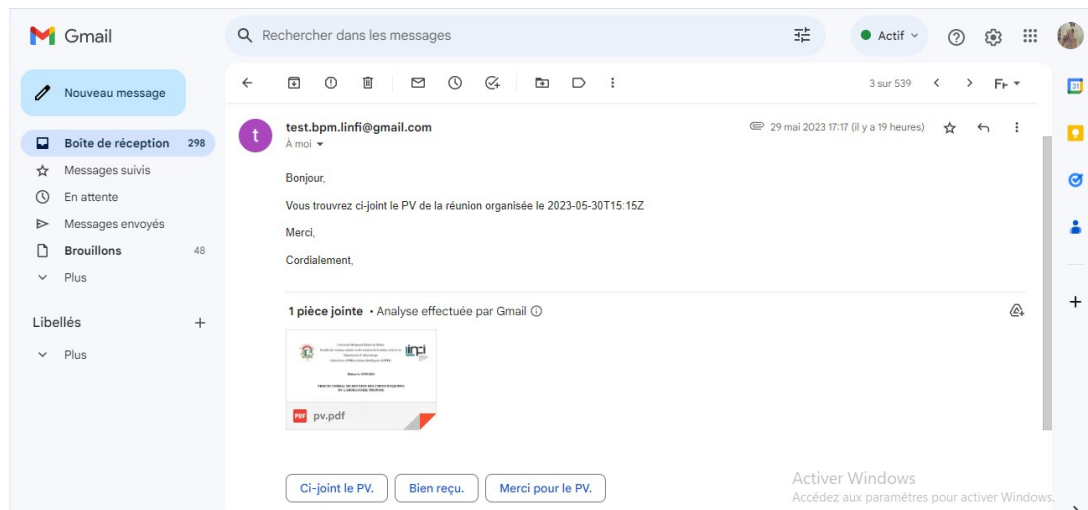


Figure 5.65: Receive reports by e-mail.

Once the CL has validated the request, it will be sent to the PG of the faculty.



Université Mohamed Khider de Biskra
Faculté des sciences exactes et des sciences de la nature et de la vie
Département d'informatique
Laboratoire d'INformatiqueIntelligente (LINFI)



Biskra Le 18/06/2023

**PROCES VERBAL DE REUNION DES CHEFS D'EQUIPES
DU LABORATOIRE PROPOSE**

Objet : ABC

ABC

Etaient Présents :

- Mme. Saouli Rachida.
- Mr. Laid Kahloul.
- Mr. Sadek Labib Terrissa.
- Mr. Khaled Rezeg.

La réunion fut levée à 20/06/2023 01:05

Signature: Hadjer

hadjer.lassel@univ-biskra.dz, 2023 17:33 GMT+2

Email: hadjer.lassel@univ-biskra.dz

Figure 5.66: PV .

Conclusion

This chapter allowed us to create our application and to understand, overall, the stages of development of a workflow application in the Bonita development environment, thanks to which we were able to proceed with its realization.

Chapter 6

Conclusion and Perspectives

The work carried out in this end-of-studies project had the objective of designing and creating a Workflow application for the "Digitization of L'INFI laboratory processes". In this project, we presented our work in two parts:

Firstly the part for the theoretical studies on workflow and business process modeling. Secondly, the part concerns the presentation of the process modeling method (**BPMN**) on Bonita open-source software for the realization of a Workflow application that meets the objectives set. This work has brought us great support to deepen our knowledge of processes, more particularly of business processes. We were also able to understand the principles of workflow, and we became familiar with groupware technologies and tools, such as **Bonitasoft** as a workflow engine.

There are several improvements that can be done in the near future to achieve a more complete tracking application, such as the possibility of connecting the application to a server which makes it possible to store all the information necessary.

Annex :

Request Airline Tickets

Mr
Département de Biskra,
Université MK de Biskra
e-mail : l...@univ-biskra.dz

À Mr la directrice du laboratoire LINFI

Biskra le, 10 Octobre 2022

Objet : Demande de billets d'avion

Madame,

Je viens par la présente vous demander de bien vouloir accepter ma demande de billets d'avion pour à la conférence EDIS'2022 pour présenter mon article accepté.

Je vous informe que ce séjour scientifique aura lieu les **2 et 03 Novembre 2022** – à ORAN.

Veuillez agréer, Madame, mes sincères salutations.

NB:

Pièce jointe : le mail d'acceptation

PV of the proposed lab meeting



Université Mohamed Khider de Biskra
Faculté des sciences exactes et des sciences de la nature et de la vie
Département d'informatique
Laboratoire d'INformatique Intelligente (LINFI)



Biskra Le 03/12/2018

PROCES VERBAL DE REUNION DES CHEFS D'EQUIPES DU LABORATOIRE PROPOSE

Objet : Accueil du professeur(INSAT, Tunisie)

L'an deux milles dix-huit et le 03 du mois de Décembre à 10h, une réunion des chefs des équipes du laboratoire d'Informatique Intelligente (LINFI) a eu lieu pour étudier l'accueil du Professeur **Professeur.....**, pour l'animation des journées scientifiques et présenter des cours au sein du laboratoire.

Le conseil du laboratoire a donné un avis favorable pour un hébergement du **Professeur**, pour les nuits 15-19/12/2018. Son arrivée est programmée pour le 15-12-2018 et son départ est programmé pour le 20-12-2018.

Etaients Présents :

Pr.Nom Prenom
Dr. Nom Prenom
Dr. Nom Prenom
Dr. Nom Prenom

La réunion fut levée à 08H30.

Equipment purchase order

Espace réservé au Service du contrôle	Populaire جمهورية الجزائرية الديمقراطية الشعبية Republique Algérienne Démocratique et			
	BON DE COMMANDE			
	N° : 03/2017	Date : 07 / 10 /2017		
Le (cette espace est réservé pour le service du contrôle financier qui appose son cachet)	Identification de service contractant			
	Dénomination: Laboratoire Etudes psychologiques et sociologiques			
	Code Gestionnaire (ordonnateur): 14608			
	Adresse: bp 145 RP 07000 Biskra			
	Téléphone et Fax			
	Identification de Prestataire			
	Nom et prénom :			
	Ou raison sociale (mentionner la forme juridique) : EURL IMTRADE			
	Agissant pour le compte de			
	Adresse: Bd frères Menani, Biskra,			
Téléphone et Fax 000-00-00-00				
N° RC: 0000000		NIF: 0000000		
N° D'agrément:		NIS: 00000000		
RIB (ou RIP) : 000-001-000-000-000-000-00 AGB AGENCE BISKRA				
Caractéristique de la commande				
<input type="checkbox"/> Travaux	<input type="checkbox"/> Dépenses de fonctionnement	Objet de la commande (détaillé): matériels informatiques et accessoires info		
<input checked="" type="checkbox"/> Fournitures	<input type="checkbox"/> Dépenses d'équipement			
<input type="checkbox"/> Services	<input type="checkbox"/> Autre			
N°	Désignation	Quantité	Prix unitaire	Montant
01	POMPE A VIDE KNF France FAIBLE DEBIT Pour Filtration sous vide Débit: 6L/mn - Ultimate vacuum (mbar abs.) 100 - Operating pressure (bar g) 2.4	00	-	-
02	AGITATEUR MULTIPOSTES (NON CHAUFFANT) DAIHAN SCIENTIFIC WISE STIR MS-MP8 - 8 POSTES Capacité de chq poste : Max 000 ml Vitesse d'agitation : 00 à 0000 tr/mn Plaque en acier inoxydable - 210 x 500 mm Temp d'agitation 99 h 59 min	00	-	-
			HT	-
			TVA 19%	-
			montant en TTC	-
Arrêté le présent bon de commande à la somme de (en lettre):				
Cent quatre-vingt-dix-neuf mille neuf cent vingt DA				
_ Le prestataire s'engage à exécuter la présente commande selon les conditions arrêtées.				
La source de financement: ..A/02/02.....				
le délai de livraison ou d'exécution est estimé à (03) mois, à compter de la date de signature du présent de bon commande				
A serguine , le 07/10/2017				
le directeur de laboratoire			le directeur de l'université	

Figure 6.3: Annex 2

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