


People's Democratic Republic of Algeria
Ministry of High Education and Scientific Research
University of Akli Mohand Oulhadj Bouira
Faculty of Sciences and Applied Science
Computer Science Department

Master Thesis

Speciality: Information Systems and Software Engineering -ISIL

Theme

A Comprehensive Workflow Management System for Computer Science Department

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2023/2024

Acknowledgments

With profound gratitude, we begin by acknowledging the Almighty and Merciful God, the divine source of our strength, patience, and courage, who enabled us to complete this humble endeavor. We extend our deepest appreciation to our esteemed supervisor, **Mr. Djellabi Brahim**, for his invaluable guidance and unwavering support throughout the project. His insightful counsel, unwavering trust, and generous assistance were instrumental in our progress. We are truly indebted to him for his dedication and time.

Our sincere gratitude extends to the esteemed members of the jury for their keen interest in our research and their willingness to evaluate our work, enriching it with their invaluable suggestions. We are deeply grateful for their contributions.

We also extend our heartfelt thanks to all our esteemed professors in the Department of Computer Science at the Faculty of Sciences in Bouira for their unwavering support and encouragement throughout our academic journey.

Finally, we express our gratitude to all those who, in any way, big or small, contributed to the successful completion of this project. Your support and encouragement have been invaluable.

Dedications

I dedicate this humble work after I thank God for all the blessings, to my mother and father who encouraged me and gave me all the support and who guided me in this life to achieve success, and to all my close friends who supported me in the university environment, not forgetting the road friend Meslem Raouane, I thank all my family members for being Support me, thank you very much.

Lamraoui Nesrine

Dedications

I dedicate this humble work, after I thank God for all the blessings, to my mother and father, who encouraged me, gave me all the support and guided me in this life to achieve success, and to all my close friends who supported me in the university environment, not forgetting the road friend Lamraoui Nesrine, I thank all my family members for being Support me, thank you very much.

Meslem Raouane

Abstract

Our project aims to address the major challenges faced by the Computer Science Department in managing its complex operations, such as managing absences, handling thesis projects, and communicating with faculty. These problems often stem from repetitive manual processes and ineffective communication, which reduce productivity and hinder optimal administrative efficiency. Currently, the department relies primarily on emails and Google Sheets for communication and coordination, leading to inconsistencies and delays in effective data processing, as well as a lack of visibility into important announcements and crucial information for faculty members.

Through our study, we propose the use of workflow management systems as an innovative solution to streamline these operations and improve service quality in complex and dynamic educational environments. Among the various challenges faced by the department, we have focused our project on managing thesis projects. The main objective of our project is to design and implement an integrated information system that manages all stages of thesis projects, from topic submission to final defense. The proposed system aims to enhance transparency, efficiency, and accountability among all stakeholders, thereby improving the experience for students and faculty.

For the implementation of this system, we utilized the open-source solution Bonita, a leader in business process automation. Specifically, we used Bonita version 2021.1 as the primary tool to achieve the project's objectives and ensure effective and efficient implementation.

Key words: Workflow management systems,Bonita , open-source...

Résumé

Notre projet vise à aborder les défis majeurs auxquels est confronté le département d'informatique dans la gestion de ses opérations complexes, telles que la gestion des absences, le traitement des projets de thèse et la communication avec le corps professoral. Ces problèmes découlent souvent de processus manuels répétitifs et d'une communication inefficace, ce qui réduit la productivité et entrave l'efficacité administrative optimale. Actuellement, le département s'appuie principalement sur les emails et Google Sheets pour la communication et la coordination, entraînant des incohérences et des retards dans le traitement efficace des données, ainsi qu'un manque de visibilité sur les annonces importantes et les informations cruciales pour les membres du corps professoral.

À travers notre étude, nous proposons l'utilisation de systèmes de gestion des workflows comme solution innovante pour rationaliser ces opérations et améliorer la qualité des services dans des environnements éducatifs complexes et dynamiques. Parmi les divers défis rencontrés par le département, nous avons concentré notre projet sur la gestion des projets de thèse. L'objectif principal de notre projet est de concevoir et mettre en œuvre un système d'information intégré qui gère toutes les étapes des projets de thèse, depuis la soumission du sujet jusqu'à la soutenance finale. Le système proposé vise à améliorer la transparence, l'efficacité et la responsabilité parmi tous les acteurs concernés, améliorant ainsi l'expérience des étudiants et des enseignants.

Pour la mise en œuvre de ce système, nous avons utilisé la solution open-source Bonita, un leader en automatisation des processus métiers. Plus précisément, nous avons utilisé Bonita version 2021.1 comme principal outil pour atteindre les objectifs du projet et assurer une mise en œuvre efficace et efficiente.

Mots clés:Systèmes de gestion des flux de travail,Bonita ,open-source ...

ملخص

يهدف مشروعنا إلى معالجة التحديات الرئيسية التي يواجهها قسم علوم الكمبيوتر في إدارة عملياته المعقدة، مثل إدارة الغيابات، ومعالجة مشاريع التخرج، والتواصل مع أعضاء الهيئة التدريسية. تنبع هذه المشاكل غالباً من العمليات اليدوية المتكررة والتواصل غير الفعال، مما يقلل من الإنتاجية ويعيق الكفاءة الإدارية المثلى. يعتمد القسم حالياً بشكل رئيسي على البريد الإلكتروني و Google Sheets للتواصل والتنسيق، مما يؤدي إلى تناقضات وتأخيرات في معالجة البيانات بكفاءة، بالإضافة إلى نقص في الرؤية للإعلانات والمعلومات الهامة في الوقت المناسب. من خلال دراستنا، نقترح استخدام أنظمة إدارة سير العمل كحل مبتكر لتبسيط هذه العمليات وتحسين جودة الخدمات في البيئات التعليمية المعقدة والديناميكية. من بين التحديات المختلفة التي يواجهها القسم ، ركزنا مشروعنا على مسألة إدارة مشاريع التخرج. الهدف الرئيسي لمشروعنا هو تصميم وتنفيذ نظام معلومات متكامل يدير جميع مراحل مشاريع التخرج، من تقديم الموضوع إلى الدفاع النهائي. يهدف النظام المقترح إلى تحسين الشفافية والكفاءة والمساءلة بين جميع الأطراف المعنية، مما يحسن تجربة الطلاب وأعضاء الهيئة التدريسية.

لاستكمال تنفيذ هذا النظام، استخدمنا الحل مفتوح المصدر Bonita ، الرائد في أتمتة عمليات الأعمال. على وجه الخصوص، استخدمنا الإصدار 2021.1 من Bonita كأداة رئيسية لتحقيق أهداف المشروع وضمان تنفيذ فعال وكفء.

الكلمات المفتاحية: نظم إدارة سير العمل، Bonita، المفتوح المصدر

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List of abbreviation

FSSA	Faculty of Sciences and Applied Sciences
CWMS	Comprehensive Workflow Management System
BPMN	Business Process Model and Notatio
WfMS	Workflow Management System
WfMC	Workflow Management Coalition
UMM	User Management Modul
OMG	Object Management Group
CSD	Department Academic Committee
JEE	Java Enterprise Edition
XPDL	XML Process Definition Language

General introduction

Computer science departments in universities today face significant challenges managing a growing number of complex and diverse operations. In addition to the core educational mission of equipping students with the knowledge and skills to succeed in this rapidly evolving field, these departments must also manage sophisticated labs, coordinate multiple research projects, and provide around-the-clock student support. These multifaceted operations are often hindered by reliance on manual processes and ineffective communication, leading to decreased productivity and frustration for faculty, staff, and students alike.

In today's technological world, workflow management represents a crucial tool for universities aiming to enhance efficiency and service quality by organizing their academic operations. This technology serves as a catalyst for continuous improvement and enhanced performance through streamlined operation within educational environments.

This thesis focuses on the challenges faced by workflow management systems in universities, with particular emphasis on the Computer Science department. The project aims to integrate and unify the lifecycle of graduation projects for students (PFE), targeting not only students and faculty members but also university administration. It aims to alleviate common challenges in communication, document management, and remote event coordination that hinder collaborative efforts within the academic environment.

The primary objective is to design and implement a robust information system capable of managing all stages of graduation projects, from initial topic submission to final defense. This system includes functionalities such as project topic submission, verification and approval processes, committee assignments, progress evaluation meetings, and

final defense scheduling. By leveraging advanced workflow management tools, the thesis aims to improve efficiency, increase transparency, and enhance accountability among all stakeholders involved in graduation projects.

To complete our work, we have adopted the following structure:

We began with a general introduction where we introduced the problem statement and outlined the objectives we aim to achieve throughout our project.

In the first chapter, we first present the host organization of our department, followed by the problem we are studying and our proposed solution.

In the second chapter,We present some generalities about workflows, their main application domains, and their roles.

Then, in the third chapter, we presented the graphical modeling notation for business processes, Business Process Model and Notation (BPMN 2), followed by the diagrams of our project.

The fourth chapter focuses on the implimentation of our project. We first present the open source software Bonita then the illustration of the interfaces of our project and we finally end our thesis with a general conclusion.

Chapter 1

Context and problematic

1.1 Introduction

A large number of software platforms are used to automate educational and academic services at the university level. However, there are other services that require automation and optimization, such as the management of a master's thesis (theme proposal and validation, theme assignment, supervision, monitoring of thesis work, thesis submission) and absence management.

During this chapter, we will present the computer science department in which the present study will take place. Understanding the difficulties and problems of this department is very important here for identifying solutions for our project. It is essential to have an overview of the organization of this department as well as its capabilities in workflow management systems.

1.2 Presentation of the university of Bouira

Akli Mohand Oulhadj Bouira University was established under the executive decree n°12-241 of 14 Rajab 1433, corresponding to June 4, 2012. It is a public establishment of a scientific, cultural, and professional nature, endowed with a legal personality and financial autonomy[5].

Following the executive decree mentioned above, the university was restructured by the constitution of (06) six faculties and two (02) Institutes, presented respectively:

1-Faculty of Sciences and Applied Sciences.

2-Faculty of Natural and Life Sciences and Earth Sciences.

3-Faculty of Letters and Languages.

4-Faculty of Social and Human Sciences.

5-Faculty of Economics, Commercial and Management Sciences.

6-Faculty of Law and Political Sciences.

7-Institute of Sciences and Techniques of Physical and Sporting activities.

8-Institute of Sciences and Technology.

1.2.1 Organizational chart of the university faculties

The following figure 1.2 shows the organizational structure of university colleges :

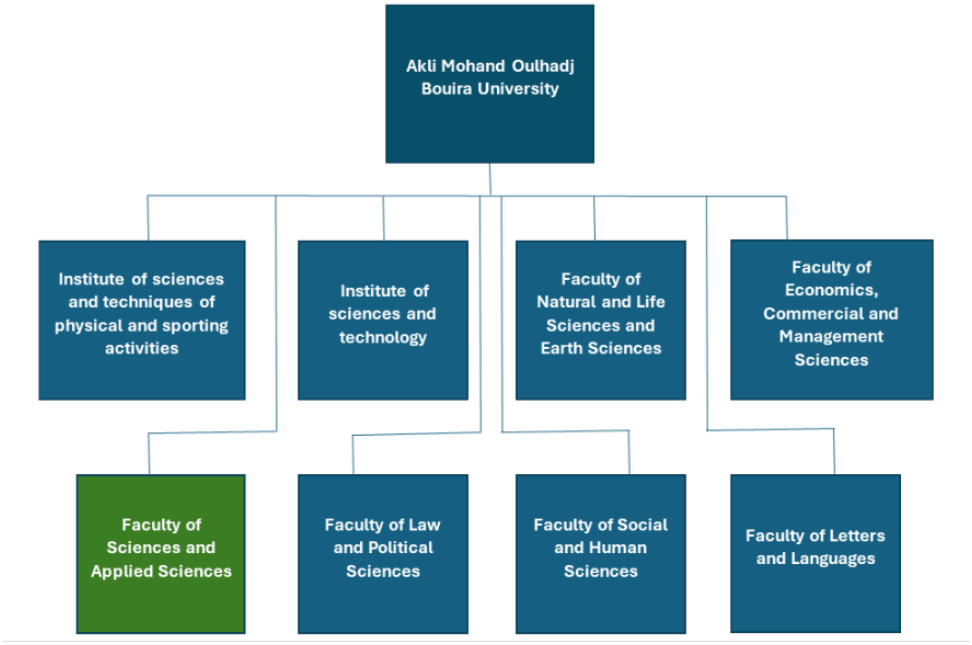


Figure 1.1: Akli Mohand Oulhadj Bouira University Colleges Organization Chart.

1.3 Presentation of the Faculty of Sciences and Applied Sciences

The Faculty of Sciences and Applied Sciences (FSSA) is a young faculty, created by Executive Decree No. 12-241 dated 14 Rajab 1433, corresponding to June 4, 2012, establishing the University of Bouira under the name 'Faculty of Sciences and Technology

(FST)'. Its name was changed to 'Faculty of Sciences and Applied Sciences' by Executive Decree No. 13-179 dated 24 Jumada al-Thani 1434, corresponding to May 5, 2013, amending and supplementing the previous text.

The faculty has eight (08) departments:

- Science and Technology Department
- Process Engineering Department
- Civil Engineering Department
- Electrical Engineering Department
- Mathematics Department
- Computer Science Department
- Chemistry Department
- Physics Department

1.3.1 The Faculty of Sciences and Applied Sciences organization chart

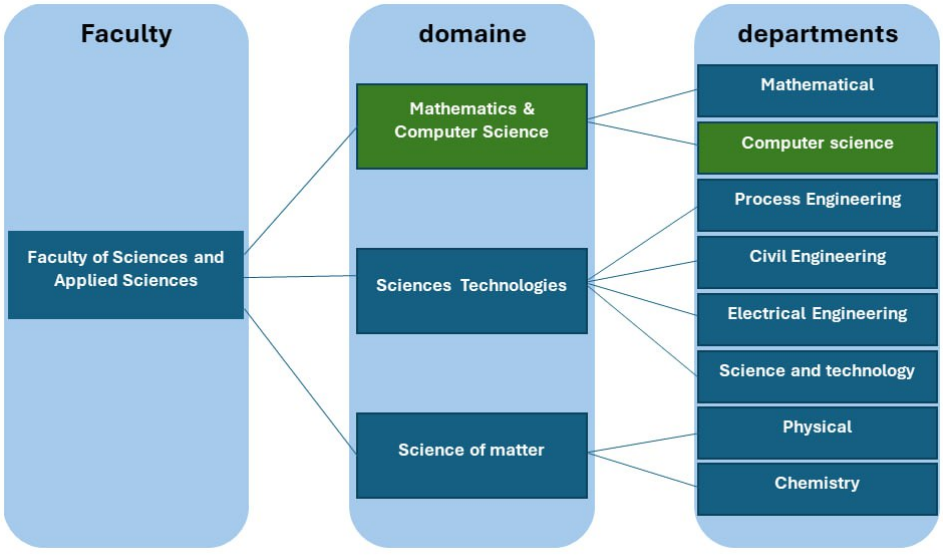


Figure 1.2: Akli Mohand Oulhadj Bouira University Colleges Organization Chart.

1.4 Presentation of the computer science department

The Department of Computer Science within the Faculty of Sciences and Applied Sciences (FSSA) offers two training programs:

a.Bachelor's degree: This program spans two years after a foundational year in Mathematical Informatics.

- Bachelor's degree Bachelor's degree in Computer Systems .

b.Master: There are three Master programs that extend over two years.

- Master in Information Systems and Software Engineering.
- Master in Management of Computer Systems.
- Master in Artificial Intelligence.

In parallel with conventional face-to-face teaching, the instructors of the Department of Computer Science offer various types of online educational materials on the university's Moodle platform to ensure the continuity of education even under different conditions that may prevent face-to-face instruction.

1.4.1 The department organization chart

The following figure 1.3 shows the organization chart for the Department of Informatics :

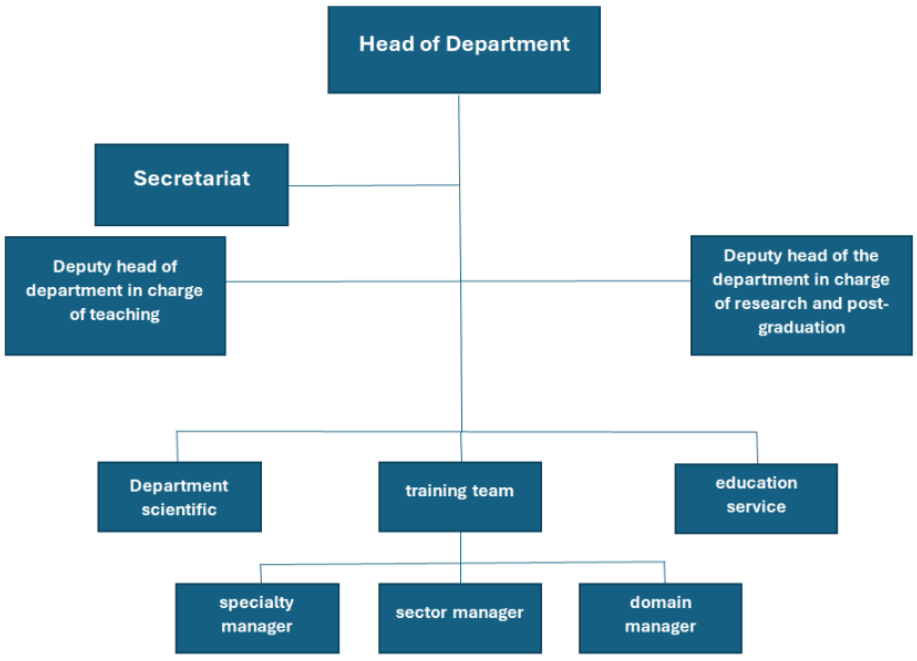


Figure 1.3: Department of Informatics Organization Chart.

1.5 Problematic

In the Computer Science department, we face numerous challenges that affect the smooth operation of administrative and academic processes. These challenges include over-reliance on email as a primary means of communication, leading to coordination discrepancies and delays in efficient data processing. Additionally, there is inefficiency in managing schedules for academic events and activities, adversely impacting the organization and effective planning of these events. These issues are pivotal aspects we will address in our thesis, focusing particularly on analyzing and finding solutions to enhance workflow management for thesis projects and improve academic services within the department.

1.6 Existing Systems in the Department

1.6.1 Progress

The digital platform or tool that the Ministry of Higher Education has mobilized aims to improve services for the benefit of the university family[6]. The following services are available:

- Platform for requests for change of assignment, orientation and consultation of the results of the evaluations.
- Inscription platform for foreign students and Algerian students holding a foreign baccalaureate.
- platform for requesting authentication of university diplomas.
- Application platform for the doctoral access competition.
- Management of accommodation, scholarship, and transport requests.
- Human resource management.
- Research management.
- Financial and accounting management.

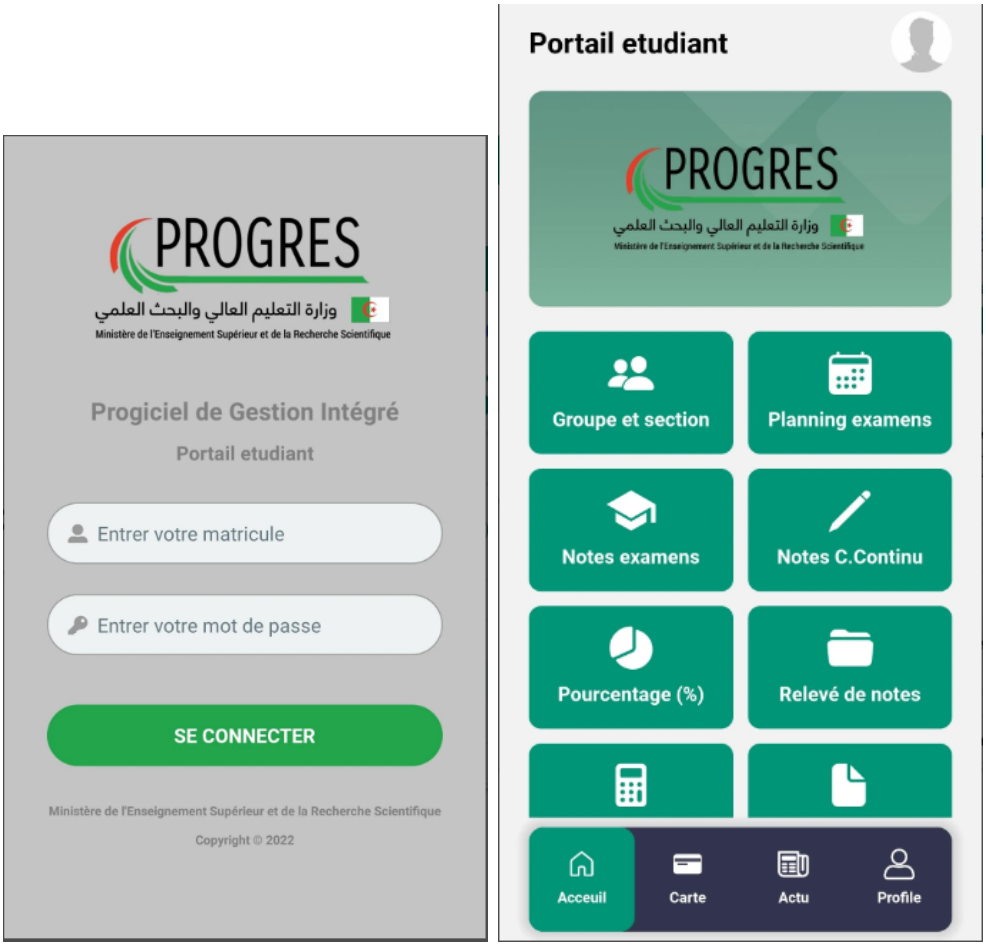


Figure 1.4: Progres WebEtu

Figure 1.5: Progres Plateform

1.6.2 E-learning (moodle)

A distance learning platform that facilitates the creation of an online learning environment and encourages communication and interaction between teachers and students on educational content. Its services include:

- Put the lessons, practical work and directed work.
- Students submit the required reports.
- Display grades.
- Deliberation.
- Display the master's subjects

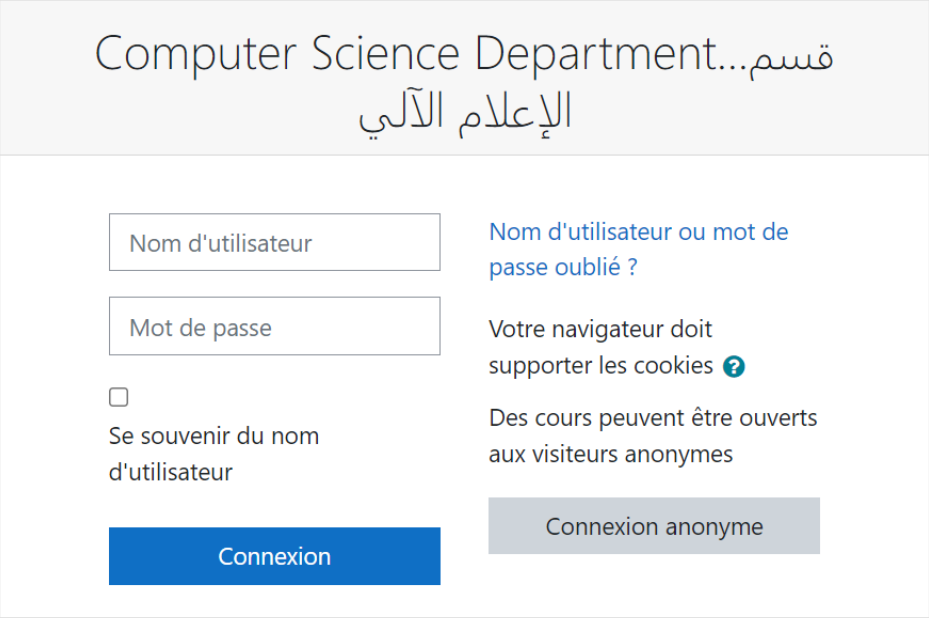


Figure 1.6: E-learning (Moodle) of the Computer Science Department

1.7 Solutions and objectives of our project

For the management of final study projects, we will create a system containing the following tasks:

- Professors suggest master's topics.

- The administration validates the themes.
- Display the master's subjects to students.
- Students choose three subjects.
- Teachers select the students they will work with from those who have selected their topics, based on criteria determined by the teachers.
- The selection process is repeated until each student has a topic and a supervisor.
- The administration monitors the progress of work on the thesis.
- The teacher methodically follows the student's work on the thesis.
- Students submit their theses.
- The administration chooses a jury for each thesis.
- Display the list of juries for each thesis.

1.7.1 Final Study Project

Definition

The final study project, typically undertaken towards the end of their academic program, whether at university or equivalent educational institutions, aims to showcase the skills, knowledge, and understanding acquired by students throughout their study period, along with their ability to conduct independent research and produce original academic work.

The stages involved in executing the final study project encompass several fundamental steps, each contributing to a comprehensive academic experience:

1.Topic and Supervisor Selection: Students begin by identifying a suitable topic for their thesis and selecting an appropriate supervisor who can provide guidance and expertise in the chosen field of study.

2.Problem Statement Definition: A crucial step involving the identification of the problem statement or research question that the thesis aims to address. This lays the foundation for the entire research process, defining the scope and objectives of the study.

3.Conducting Research: A comprehensive research phase is undertaken to gather literature, data, and relevant information related to the chosen topic. This stage ensures that the thesis is well-grounded in current knowledge and contributes to academic discourse.

4.Thesis Writing Plan: An organized plan is developed to outline the structure and flow of the thesis. This includes identifying chapters, sections, and key points that will effectively convey the results and analysis.

5.Thesis Drafting: Based on the research conducted and the thesis writing plan, students draft the thesis manuscript. This involves compiling gathered information, presenting arguments, analyzing data, and drawing conclusions based on research findings.

6. Preparation for Presentation: In preparation for the final defense or presentation, students refine their presentation skills. They organize their findings cohesively, prepare visual aids, and anticipate questions from the evaluation committee.

The structure and requirements of the final study project vary across different academic disciplines, but it consistently represents a critical evaluation of students' academic and research capabilities. It signifies a significant milestone in their educational journey, demonstrating their readiness to contribute to their field of study through meticulous academic inquiry and scholarly production.

1.8 Conclusion

This chapter centered on the computer science department of the faculty of sciences and applied sciences at the University of Bouira. Following an introduction to the host organization and its systems, the challenges it encounters were emphasized. A solution was put forward to address one of these issues, emphasizing its benefits and its potential to enhance the department's condition.

In the next chapter we will focus on the presentation of the notion of workflow and its role in the departement.

Chapter 2

Workflow and workflow management system

2.1 Introduction

Using workflow management systems has become increasingly important in recent years as organizations strive to optimize processes and increase efficiency. Universities are no exception, as they face the challenge of managing complex workflows related to student admissions, course scheduling, academic advising, research management, and many other tasks. Existing workflow management systems often need to be adapted to the specific requirements of universities. They may require critical capabilities such as integration with existing academic systems and support for complex approval processes. Therefore, a specialized workflow management system is needed to meet the unique needs of universities and improve the overall efficiency of their operations.

This chapter introduces the fundamentals of workflow and workflow management systems (WfMS) within cooperative information systems. We will explore workflow definitions, historical development, lifecycle stages, and categories. Additionally, we will examine the key components and functionalities of WfMS, highlighting their role in enhancing university operations.

2.2 Cooperative Information System

A cooperative information system is an information system that enables collaboration between human or artificial actors by sharing data, knowledge, resources, and services. The goal of a cooperative information system is to facilitate coordination, communication,

cooperation, and negotiation between participants in a collective process. There are different types of cooperative information systems, depending on the degree of automation, the mode of synchronization, the level of formalization, and the scope of application. Examples of cooperative information systems include workflow systems, groupware, multi-agent systems, collective decision support systems, and collaborative learning systems.

2.3 Workflow

2.3.1 Definition

A workflow involves automating either fully or partially the execution of business processes. During this process, documents, information, and tasks move from one participant to another to perform specific actions based on predefined rules. Workflows consist of a series of actions (steps) that follow a predetermined sequence. These actions can be sequenced based on conditions, interactions with other workflows, or human interventions. Activities, also known as actions, are reusable components representing steps within a workflow. Workflows are machine-interpretable representations of business processes, comprising a network of activities with dependencies, criteria for process initiation and completion, and details about individual activities such as participants, applications, and associated data. Activities and processes involve input and output data organized into data containers[7].

2.3.2 History

The 1970s saw a resurgence of social criticism of the division of labor. the last It is considered a factor in the regression of social organizations, in particular the poor functioning of businesses.In the 1980s, the spread of automation seemed to raise questions about automation technology. Labor Practice Division.

Electronic imaging and computer-aided production management industry The first uses technology capable of automating work procedures previously carried out manually.

From 1975 to 1985, a new technology called workflow emerged. The company has grown significantly by implementing systems that automate workflows as much as possible. Workflow software solutions implemented in the 1990s were based on About workflow

engines and rules. Their main purpose is to replace paper Automatic activity routing task library with form flow Electronic. The renewed interest in software engineering in the early 1990s helped to revive Search for workflow systems for more user-friendly systems. By the late 1990s, advanced features such as professional rule engines, policy management, modeling tools, and monitoring and optimization processes were included in the market for work flow software. The idea was to segregate the data and processing related to work procedures in order to provide a greater level of convenience for the creation, modification, or suppression of work procedures. These days, businesses use these "new" systems extensively and they are fully functional. It doesn't mean that more research won't be done to achieve even more souplessness and adaptability. It is in this particularly flexible framework that the adaptable workflow has emerged. These days, work flow software needs to adhere to the complete BPM discipline of modeling, execution, simulation, optimization, and functionality control[8].

2.3.3 Workflow Life Cycle

The workflow life cycle (Figure 2.1) essentially consists of two phases[9]:

1) The first step is dedicated to modeling (or editing) the process, that is to say to designing the flowchart. It is also found under the English term "Build time". In most workflow management systems (WMS), a graphical environment is provided for this step.

2) The second step is dedicated to the instantiation of the flowchart called "Case" and its execution. Execution may involve external users and/or applications. This step is recognized by the English term "Run time". The software component responsible for this step is called the workflow engine.

The figure below represents the workflow lifecycle.

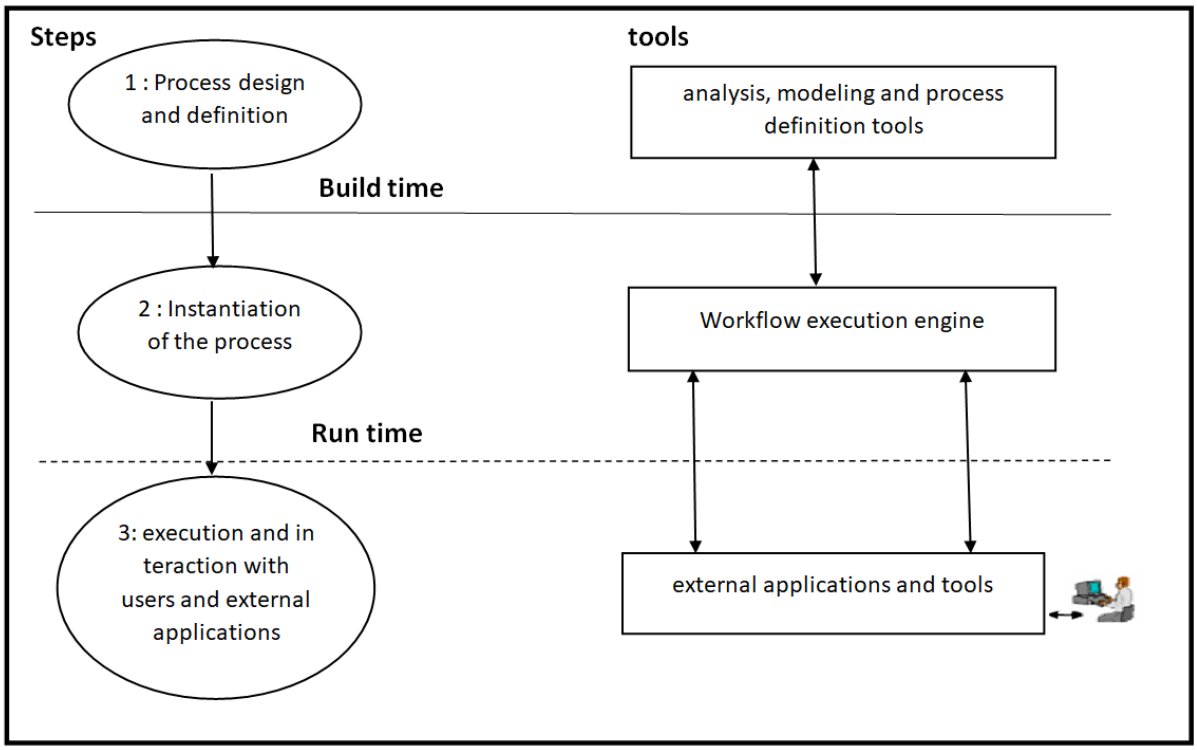


Figure 2.1: workflow life cycle.

In order to effectively utilize WF, it is important that they integrate the following skills:

- Support changes to process models.
- Enable monitoring of process execution.
- Enable distribution of processes across business areas. Support allocation of resources and process steps.

2.3.4 Workflow Categories

Workflow categories refer to different classifications or types of workflows based on their characteristics, functionalities, and applications. Here are some common categories of workflows[10]:

1.Collaborative Workflow: Suitable for people working together with a common goal. It can be used for non-transactional, critical processes. Collaborative workflow do not require progressive workflows .They allow tasks to be repeated until some agreement is reached and even allow backtracking to previous stages. Collaborative workflows are highly dynamic and can be continuously defined.

2.Ad Hoc Workflow: Suitable for unstructured activities, providing enough flexibility for simple processes in a changing environment. This type of workflow allows users to create new definitions of simple processes and customize existing processes easily . This is important for changing process instances based on specific circumstances. It can be applied in areas where productivity and security are not the main considerations.

3.Administrative Workflows: These workflows make it straightforward to define basic processes. Forms are used to formalize the process specification, which works well for repeated, organized processes with straightforward coordination rules. They typically work effectively to depict bureaucratic procedures with clearly defined steps and widely understood operating guidelines.

4. Production Workflow: Suitable for highly automated processes when the number of events requiring human participation is low. Additionally, the duration and complexity of interventions must be kept to a minimum.Production workflows make it possible to consistently perform repetitive tasks which are often completed continuously more efficiently. The procedures themselves could be extremely intricate and closely linked to other organizational structures. This type of workflow works well for business procedures like loan and insurance processing.

5.Transaction-Oriented Workflow: Emphasizes a process's operational components and ensures that an application is correct in cases of failure and concurrency. It can be used to consolidate procedures between different organizations.

2.3.5 The Main Concepts of Workflow

The fundamental principles of workflow, encapsulated by the "3R" metaphor (Routing, Rules, Roles) coined by Ronni Marshak in 1993, outline key aspects of workflow management[8]:

Routing: Directing documents, information, or tasks along defined pathways within a workflow system.

Rules: Establishing coordination guidelines for task execution, encompassing management rules, forms, data handling, and applications.

Roles: Managing resources (roles) responsible for task execution and intercommunication.

This metaphor effectively illustrates how workflow systems operate, emphasizing:

a)Routing: Orchestrating activity synchronization and pathway management from one task or role to another, is essential for electronic information, document, and file routing. This can be sequentially predetermined or dynamically governed by rule-based criteria, thereby optimizing process dynamics.

b) Rules: Formalizing coordination rules ensures streamlined task execution and information flow between individuals, integral to workflow efficiency and compliance.

c)Roles: Defining role-specific responsibilities ensures tasks are performed effectively, focusing on function rather than individual identity within the workflow process. This approach underscores the role-based nature of workflow management, acknowledging that tasks are not exclusively carried out by individuals but by designated roles within the system.

2.3.6 Basic Workflow Concepts

1.Identify the process: the process that needs to be automated or improved.

2.Define the steps: down the process into individual steps and identify the dependencies between them.

3.Design the workflow: Create a visual representation of the workflow, including the steps, dependencies, and decision points.

4.Configure the workflow: Configure the workflow in a workflow management system, including defining the triggers, actions, and rules.

5.Test the workflow: Test the workflow to ensure that it works as expected and meets the requirements.

6.Deploy the workflow: the workflow to the relevant users or systems.

7.Monitor and optimize the workflow: Monitor the workflow to identify any issues or areas for improvement, and optimize the workflow as needed.

2.3.7 Workflow Engine

A workflow engine is a software tool that provides the runtime, that is, the execution environment for process instances. The workflow engine must provide all the functions necessary for the execution of process instances based on process definitions [11]. These

functions include:

- Interpreting process modules or definitions.
- Creating process instances and managing them from start to finish, including starting, suspending, resetting, etc.
- Navigating between activities and creating appropriate work orders.
- Supervising and overall controlling the workflow.

Examples of Workflow Engines:

- **BonitaSoft:** A Java-based workflow engine compliant with WFMC standards. It is distributed as open source under the GNU LGPL license.
- **ProcessMaker:** An open-source workflow management platform that enables modeling, automating, and optimizing business processes.
- **Camunda:** Provides an open-source community edition under the Apache License 2.0. It also offers an enterprise edition with additional features under a commercial license.
- **Activiti:** Available as an open-source project under the Apache License 2.0.
- **openCS** A web-based workflow engine designed to offer online process automation capabilities.
- **FlowMind:**A multi-platform workflow/BPM engine tailored for software editors, coupled with the Leonardi framework.
- **JBoss jBPM:**A Java-based workflow engine.

2.4 Workflow Management System

A Workflow Management System (WfMS) is a system that defines, implements, and oversees the execution of workflows using software environments powered by one or more workflow engines. It interprets process definitions, coordinates participant interactions, and invokes external applications in a predetermined sequence defined within a digital

representation of procedural logic. Similar to a database management system, a WfMS serves as the foundational infrastructure supporting workflows and their associated business processes[12].

2.4.1 The Reference Model for Workflows

To establish standards within the realm of workflow systems, the Workflow Management Coalition (WfMC) was formed by software vendors, research laboratories, and system users. This consortium aims to promote and advance workflow systems. To achieve these goals, they have developed a glossary to unify terminology and defined a reference model, centered around the execution engine as depicted in the accompanying(Figure 4.18)[13].

This model outlines fundamental components and interfaces crucial for ensuring interoperability among diverse workflow products.

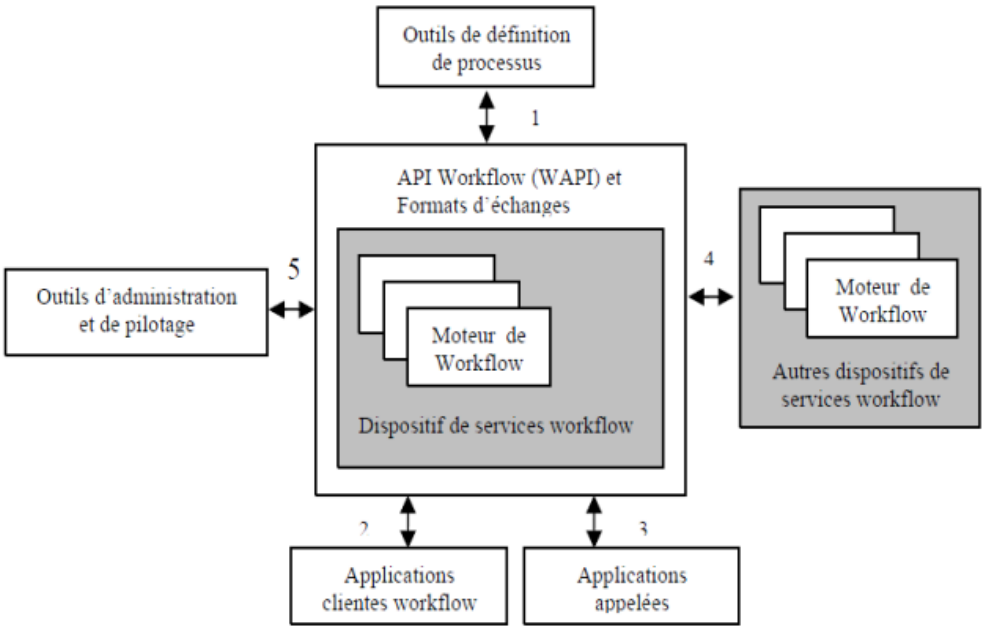


Figure 2.2: Workflow management system architecture (WFMC,1999).

a. Workflow Service Provisioning: This software service consists of one or more Workflow Engines of the same type, used for defining, managing, and executing workflow procedures.

b. Workflow Engine: This software service provides some or all of the execution environment for a workflow.

c. Interface 1: Links workflow creation and modification tools with the workflow engine.

d. Interface 2: Facilitates communication between client workflow applications and the workflow engine.

e. Interface 3: Allows specific applications associated with a given activity to be invoked for executing particular tasks.

f. Interface 4: Enables interoperability and work exchange between multiple autonomous workflow management systems.

g. Interface 5: Facilitates connectivity between administration and monitoring tools and the workflow engine. It is divided into two parts:

- Workflow management system functions and workflow routing functions.
- Administration and monitoring tools can audit, for example, wait times, completion times, execution times, and routing[12].

2.4.2 Characterization of Workflow Management Systems

Workflow Management Systems (WMSs) can be described in various ways, ranging from the user interfaces they offer to the types of provenance records they provide. The list of WMS features for computational research is growing due to the increasing complexity of extreme-scale applications and the ever-increasing heterogeneity of computing capabilities. Therefore, users need a new viewpoint to assist in making decisions. We concentrate on the aspects of WMSs that are most important for overseeing newly developed extreme-scale workflows. These characteristics are arranged into three properties. We outline these attributes and the features that go along with them in this section[1].

1.Workflow Execution Model:

Let's examine how two workflow tasks are carried out under the supervision of a central WMS. Any kind of code, including single-core programs, code fragments, parallel applications, MapReduce algorithms, etc., can be used for the tasks. Data can be communicated between tasks using files, RAM, object stores, databases, and other means.The tasks' potential models of interaction are depicted in (Figure 2.3). We separate the following two groups:

(1) Acyclic Group: The models in this group match those found in the most recent WMSs.

(2) Cyclic Group: This term describes the presence of cycles in the model, particularly in the way the two tasks interact or, more crucially, how they interact with the WMS. The cyclic group contains execution modes that are uncommon in modern WMSs but will be crucial in the transition to extreme-scale[1].

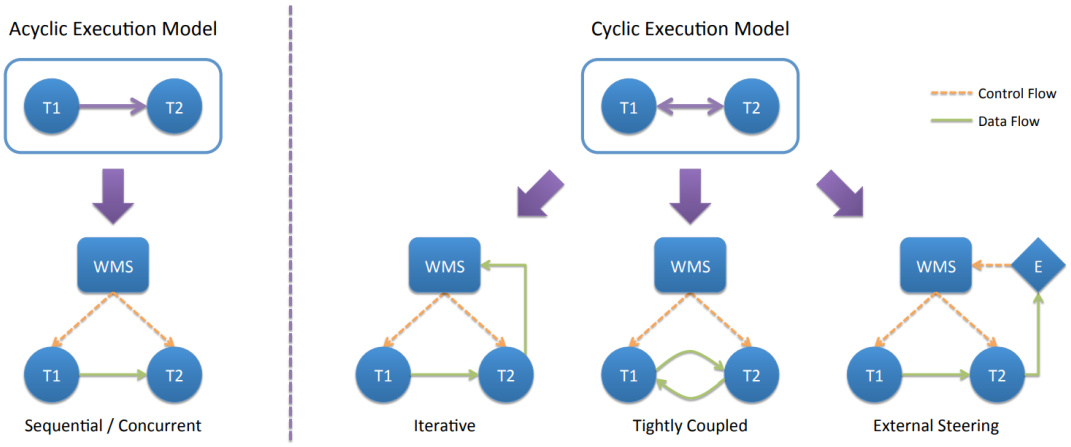


Figure 2.3: Five different workflow execution models, divided into two groups[1].

We distinguish between the following execution models[1]:

•**Sequential:** The WMS initiates T1, waits for T1 to finish processing its data, and then initiates T2. This is a typical workflow paradigm where post-processing follows the simulation phase.

•**Concurrent:** T1 generates data that T2 uses, and T1 and T2 run simultaneously. This approach facilitates the processing of streaming data through multiple stages of workflows, such as using various feature detection algorithms. Concurrent execution, rather than simple parallelism, better describes this model.

•**Iterative:** The WMS initiates T1, processes its data, ends T1, and then initiates T2.

Whether the sequence is repeated or not depends on the outcomes of T2.This paradigm is useful for iterative parameter space exploration through Uncertainty Quantification (UQ) procedures.

•**Tightly coupled:** T1 communicates with T2 about partial results, and vice versa. This model suits workflows where two simulations are closely coupled and advance together over time, such as a multi-physics simulation combining hydrodynamics and radiation transport or a cross-correlation study.

•**External steering:** T2's findings are examined by a user or system, who may choose to modify T1's execution or take other actions. The basic semantics remain the same as in the Concurrent scenario. In this case, T1 might be a simulation providing data to T2's data analytics process. After analyzing the results, the user may modify T1's behavior or another step in the workflow, like data collection.

2.Heterogeneous Computing Environments:

Managing workflows within and between different High-Performance Computing (HPC) systems is crucial. HPC operations often require cleaning, calibrating, or post-processing input data on different resources. A Work Management System (WMS) must coordinate workflows across multiple resources.

In an HPC system, the WMS might need to schedule simulations and visualizations, manage data flow through memory layers, and co-locate with calculations. This coordination must occur within the system, not externally. WMS features include:

- Co-location with the Execution System:Ensures effective job execution within the HPC system.
- External Location to the Execution System: Manages coordination outside the HPC system.
- In Situ Execution: Executes tasks within the system as data is generated.

•**3.Data Access Methods:**

Controlling data access via a variety of infrastructure-provided mechanisms is necessary for controlling computations in heterogeneous contexts. Access to data files kept on drives, in object stores, memory, or in external storage may be required for tasks.These techniques arrange data in a way that a task requires. Memory, messages, local disk, shared file systems, object stores, and other remote storage are features that are connected

to these techniques.These techniques guarantee that the data is arranged as required by the task.

2.4.3 Components and Modules

1.User Management Module (UMM): The User Management Module facilitates the management of user access and content visibility within the application. Key features include access control, authentication, and permission consolidation. This module ensures complex access control across all applications used and provides a user-friendly interface for administrators. It optimizes the time required to access specific applications, thereby enhancing overall business effectiveness.

2.Task Assignment and Tracking Module: This module is essential for assigning, tracking, and managing tasks. It includes features such as task ownership and assignment to specific members or teams, time tracking, and task management. Additionally, it allows for the organization and prioritization of tasks and the identification and labeling of dependent tasks, ensuring efficient task management.

3.Communication Module: The Communication Module integrates various communication tools to enable seamless collaboration. Features include in-task comments, user mentions, and real-time notifications. These functionalities facilitate effective communication and teamwork, ensuring all team members are informed and engaged.

4.Document Management Module: This module provides comprehensive features for document version control, sharing, and collaboration. Key capabilities include document version control, unique IDs and tags, archiving, moving, and deleting documents, as well as structure management. These features ensure documents are well-organized, easily accessible, and collaboratively managed.

5.Resource Allocation Module : The Resource Allocation Module includes tools for the efficient allocation of human and material resources.It typically involves features for resource planning, allocation, and optimization, ensuring the effective utilization of available resources. This module helps in planning and distributing resources to meet project demands and improve overall productivity.

2.4.4 Functionalities and Features

The functionalities and features of a Workflow Management System (WfMS) are designed to streamline business processes, enhance collaboration, and improve overall efficiency. Here's an overview of key functionalities and features often found in a WfMS:

1. Workflow Design and Modeling:

- **Graphical Workflow Editor:**Intuitive interface for designing workflows visually.
- **Task Sequencing:**Define the order and dependencies of tasks within a workflow.
- **Conditional Logic:**Implement decision points and branching within workflows.

  Reusable Components: Create and reuse workflow templates or sub-processes.

2.User Management and Access Control:

- **Role-Based Access Control (RBAC):**Assign different roles with specific permissions.
- **User Authentication:**Secure login mechanisms to verify user identities.
- **User Profiles:**Store and manage user information and preferences.

3. Task Assignment and Tracking:

- **Task Assignment:**tasks to individuals or roles.
- **Deadline Management:**Set and track deadlines for task completion.
- **Priority Setting:**Assign priority levels to tasks.
- **Task Progress Monitoring:**Real-time tracking of task status and progress.
- **Automated Escalations:**Escalate tasks in case of delays or issues.

4. **Communication and Collaboration:**
   - **Messaging and Notifications:**Real-time communication through messaging and notifications.
   - **Commenting and Discussions:**Collaborative features for discussions on tasks or workflows.
   - **Email Integration:**Seamless integration with email for communication and alerts.
5. **Document Management:**
   - **Version Control:**Manage and track different versions of documents.
   - **Document Sharing:**Collaborate on documents within the workflow.
   - **Access Control:**Control who can view, edit, or approve documents.
   - **Document Approval Workflows:** Facilitate approval processes for critical documents.
6. **Reporting and Analytics:**
   - **Real-time Monitoring:**Track workflow progress in real-time.
   - **Performance Analytics:**Generate reports on workflow efficiency and bottlenecks.
   - **Audit Trail:** Maintain an audit trail for compliance and accountability.
7. **Integration and Connectivity:**
   - **APIs (Application Programmin Interfaces):**Facilitate integration with other systems.
   - **Connectors:** Pre-built connectors for popular third-party applications.
8. **Resource Allocation:**
   - **Human Resource Allocation:**Assign and schedule human resources to tasks.
   - **Material Resource Management:**Manage non-human resources required for tasks.
   - **Optimization Tools:** Optimize resource allocation for efficiency.

9. Error Handling and Recovery:

- **Exception Handling:**Manage errors or exceptional situations within workflows.
- **Retry Mechanisms:** Automatically retry failed tasks.

10. Security and Compliance:

- **Data Security:**Ensure the security of data within the system.
- **Compliance Monitoring:** Ensure workflows adhere to regulatory and organizational standards.

11. Mobile Accessibility:

- **Mobile-Friendly Interface:**Access and manage workflows through mobile devices.
- **Push Notifications:** Receive alerts and updates on mobile devices.

12. Scalability and Performance:

- **Scalability:**Ability to scale the system to accommodate growing workflow demands.
- **Performance Optimization:** Continuous optimization for faster execution and response times.

These functionalities and features collectively contribute to the effectiveness of a Workflow Management System, empowering organizations to automate, monitor, and optimize their business processes. The specific features may vary based on the chosen WfMS platform and organizational requirements.

2.5 Conclusion

In this chapter, we introduced the concept of workflow. We discussed the definition of cooperative information systems, the definition of workflow and its characteristics, its types of applications, its typologies, its functionalities, and its basic concepts, especially concerning the three Rs (Role, Rule, and Route).

In the next chapter, Proposed BPMN Design, we will delve into detailed workflow models using BPMN (Business Process Model and Notation).

Chapter 3

Proposed BPMN design

3.1 Introduction

This chapter centers on BPMN (Business Process Model and Notation), a standardized graphical notation pivotal for modeling business processes. BPMN plays a crucial role in enhancing workflow clarity and efficiency within organizations by providing a unified language for process documentation.

We will explore basic BPMN concepts and essential diagram elements that are fundamental for designing and analyzing processes effectively. These elements will be applied to visualize and optimize various stages of our project, aimed at improving project management and operational efficiency within academic contexts.

By leveraging BPMN diagrams, we aim to streamline workflows, facilitate collaboration, and ensure clear communication across all stages of our academic project management processes.

3.2 Presentaion of BPMN

Business Process Model and Notation (BPMN) is a standardized method for graphically modeling business processes, depicting an organization's value chains and business activities. It serves as the international standard ISO/IEC 19510 and was initially developed by the Business Process Management Initiative (BPMI), later maintained by the Object Management Group (OMG) following their merger in June 2005.

BPMN 2.0.2, the current version since 2013, further refined the notation system. It became an ISO standard in July 2013, marking its evolution from earlier versions introduced by BPMI (starting with version 1.0 in February 2006). Subsequent versions, including 1.1, 1.2, and the pivotal 2.0 in January 2011, expanded BPMN's capabilities with features like conversation diagrams, choreography diagrams, and enhanced event specifications. The adoption of BPMN by ISO as ISO/IEC 19510:2013 solidified its status as a robust framework for modeling business processes. Minor updates continued with version 2.0.2 in December 2013, primarily focusing on XML model exchange file improvements.

BPMN's evolution underscores its importance in standardizing and improving the clarity, interoperability, and efficiency of business process modeling across various industries and organizational contexts[3].

3.3 Basic Concept of BPMN

This section introduces the different concepts of BPMN to showcase the tool's full capabilities in terms of modeling.

BPMN is based on three types of models:

1. **Process Models:** These represent the progression of processes within an organization and include public processes that interface with external third-party activities.
2. **Collaboration Models:** These depict multi-entity processes and the exchanges that link these processes.
3. **Choreography Models:** These illustrate the expected behavior of participants in a process [3].

For our project, we utilized Process models.

3.4 Basic Elements of BPMN

BPMN not only represents internal business processes but also B2B processes through common flows and choreography, as well as advanced process choreography concepts such

as exception management and transaction clearing. BPMN is a language that is completely workflow-centric, focusing on the basics of activities, events, and connections.

BPMN considers three levels of complexity, where BPMN symbols serve a dual purpose: they visually represent process flows, and flowcharts can be converted into computer applications. BPMN elements can also be classified according to three levels of complexity: basic, intermediate, and advanced. These models combine the following core elements:

Activities: Tasks that need to be performed.

Events: Occurrences that affect the flow of the process.

Gateways: Decision points that dictate the path of the process.

Connections: Links that connect activities, events, and gateways.

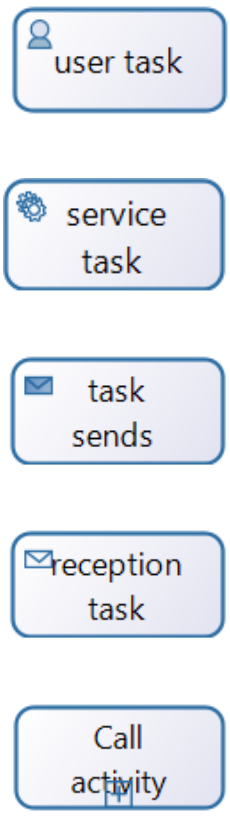
These core elements and the changes in activity notation further clarify the meaning of the model [3].

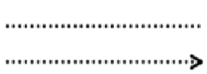
	Basique	Intermédiaire	Avancé
Activités	Abstraite	Humaine Service Appelante	
Événements	Début Fin	Message Minuterie Erreur Signal	Sous-processus événementiel
Portes	Parallèle Exclusive	Inclusive	
Flux séquentiel	Séquence	Flux conditionnel Flux par défaut	
Autre	Pools Lanes		Boucle Multi-instance
	Annotation Liens		

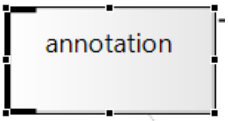
Table 3.1: Categories of Basic BPMN Elements[2].

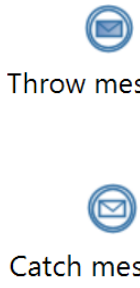
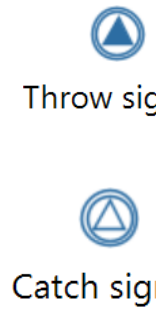
BPMN modeling elements are categorized into several general categories: Workflow elements, Organizational elements, Readability elements, and Specific Behaviors.

BPMN ELEMENTS USED IN OUR PROJECT: To model our various workflows, we used the basic elements of the BPMN assessment shown in the table. The reading direction of the workflow is from right to left. A more detailed description and explanation of these elements can be found here.

Workflow elements		
Activities and Tasks: All the work that is done in a process. Activities can represent multiple levels of detail. Tasks can be performed by people, systems, or sub-processes.		**User task:** A manual task initiated and executed by a teacher or student. **Service task:** A task executed by a computer service without human intervention. **Sending task:** A communication task. **Receiving task:** A communication task between participants or services. **Subprocess:** An activity composed of multiple tasks, using the symbols "activity", "trace", "event", and "sequence flow".
Events: used to start or finish a process and manage specific actions during this one.		**start:** An event that triggers a process or subprocess. **End:**An event marking the completion of an activity or task.

Gateways: Allow control flows to be split or converged.		**Exclusive Gateway:**An exclusive gatway evaluates the state of the business process and, according to the defined condition, passes the stream on a particular path, to the exclusion of others.
		**Inclusive Gatway:**An inclusive gateway specifies that one or more available paths will be taken. They could all be taken, or only one of them.
		**Parallel Gateway:**A Parallel Gateway is used to synchronize (combine) parallel flows and to create parallel flows.
The connection objects: illustrate how the different pieces connect to each other.		**Sequence flows:**Indicates the order of the activities to be performed. It is represented by a straight arrow line. It can be a conditional flow or a default flow.
		**Association:**Represented by a dotted line, it associates an artifact or a text with an event, an activity or an entry.

Organizational elements :		
Pools and lanes: Elements for organizing the different aspects of a process in a diagram.		They visually group objects, with each aspect of a process being added in a separate element. These elements can be arranged horizontally or vertically. They serve to organize activities into separate categories and different actors.
Group: A group shows a logical grouping of activities but does not alter the flow of the diagram.		**For example:** Visually grouping a series of tasks to make them more visible in the workflow.
Readability elements:		
Annotation: An annotation provides additional explanations about a part of the diagram.		**For example:**the student can create or view a reading record in an available database.
Links: They enable a lengthy process to be split for better readability and continued on another line within the same pool.	 **source links**  **destination links**	

Specific behaviors:		
Message symbol: Triggers, facilitates intermediate processes, or completes the process.		A message can be sent or received, similar to an email or text message.
Timer symbol: Represents a specific time or date, whether unique or recurring. This symbol is used to trigger, facilitate intermediate processes, or conclude the process.		Timer symbols can indicate the start of a timer (for instance, customers can cancel a free trial within a 30-day period, otherwise they will be charged a monthly fee), or a specific day of the week (for example, the system compiles a list of recent free trial recipients).
Signal Symbol: A signal that travels across various processes. This symbol can initiate, facilitate, or conclude a process.		
Error Symbol: Error detected at the beginning, middle, or end of a process. An error-triggering event subprocess always interrupts the process that contains it.		

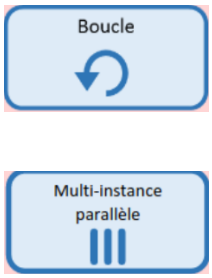
Loops and multi-instances: They are employed for tasks that involve multiple instances of the same task (multi-instance) or the iterative repetition of a task (loop).		

Table 3.2: The Main BPMN Elements Used in Modeling of our project[3][4].

3.5 BPMN Diagrams for Our Project

This series of steps aims to streamline the management of graduation projects within the Department of Computer Science using BPMN technologies and the BonitaSoft system. This approach enhances interaction between students and professors, ensuring high levels of efficiency and quality throughout all project stages, from idea submission to final project evaluation.This figue 3.1 represents the overall Final Study Project process

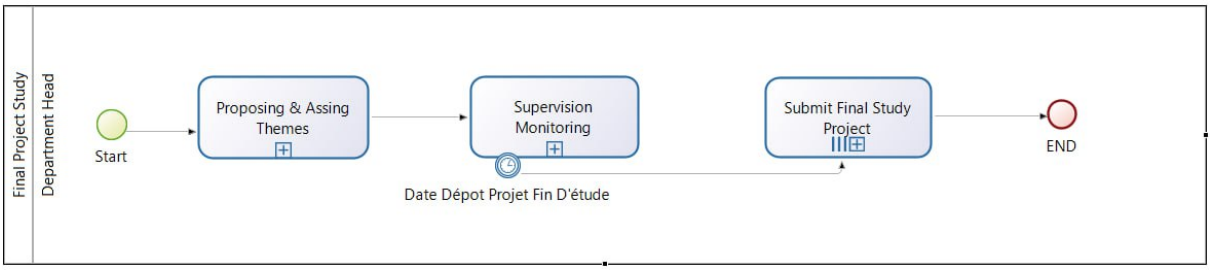


Figure 3.1: Final Study Project.

3.5.1 Project Launch.

Process:

Launching Graduation Projects by Department Head.

Department Head Entering Information: The department head enters the following information into the system:

- Number of available teachers to supervise projects.

- Number of enrolled students undertaking graduation projects.

Final dates for:

- Proposal of project themes.
- Selection of themes by students.
- Final validation of selected themes.
- Submission deadline for session 1 reports.
- Submission deadline for session 2 reports.

Automatic Calculation: Minimum Number of Themes to Propose.

The system automatically calculates the minimum number of project themes to be propose based on the teacher-student ratio and set deadlines.

Email Notification: Teachers.

The system automatically sends an email notification to all teachers, informing them of the deadlines and steps involved in the graduation project management process.

Launch of Sub-Process:

Based on the information entered by the department head, the system initiates the sub-process for proposing , choose project themes.

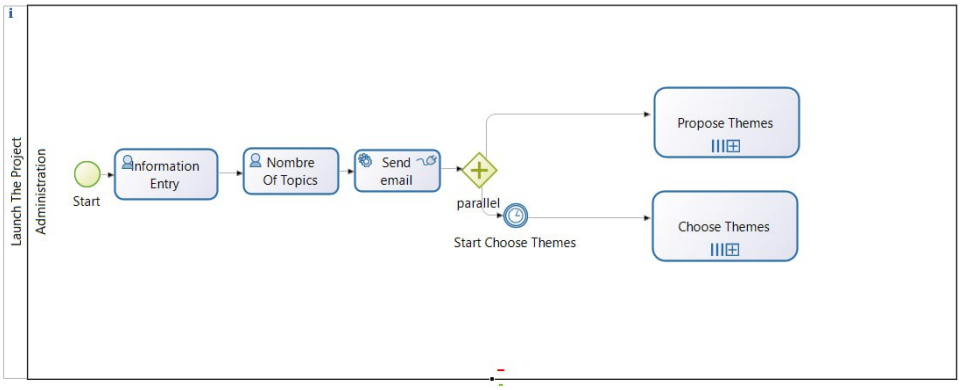


Figure 3.2: Project Launch.

3.5.2 Proposing Project Themes

- Each professor submits a set of topics within their expertise.
- Themes are submitted using a specific form that includes the topic title, a brief description, objectives, and expected methodology.

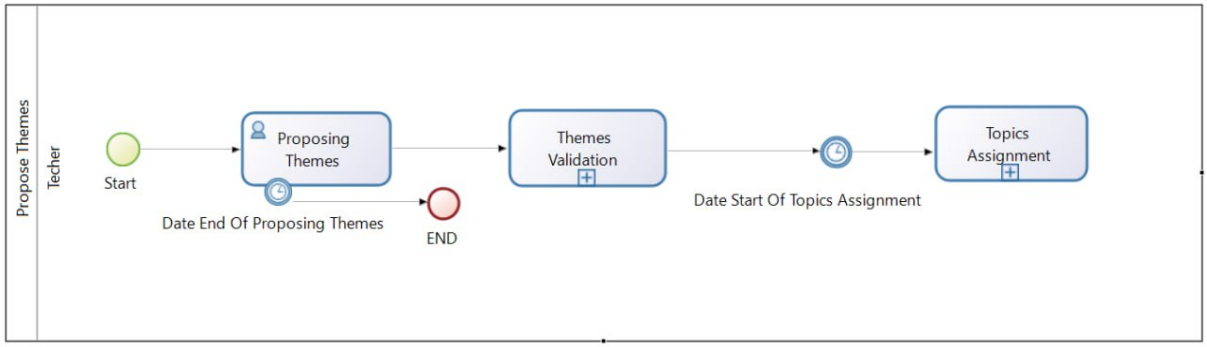


Figure 3.3: Proposing Project Themes.

3.5.3 Validation of Themes by the CSD

Once the teachers have submitted their proposals, the Department Scientific Committee (CSD) reviews and validates the themes to ensure they are relevant and meet the required academic criteria.

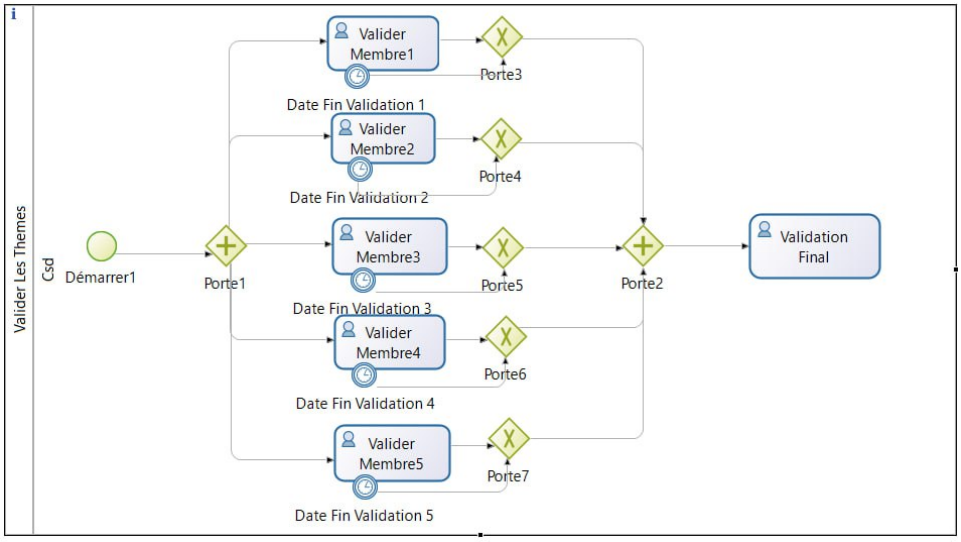


Figure 3.4: Validation of Themes by the CSD.

3.5.4 Theme Selection by Students

Once the themes are validated, students can review the list of approved themes and choose the one that aligns best with their interests and academic objectives.

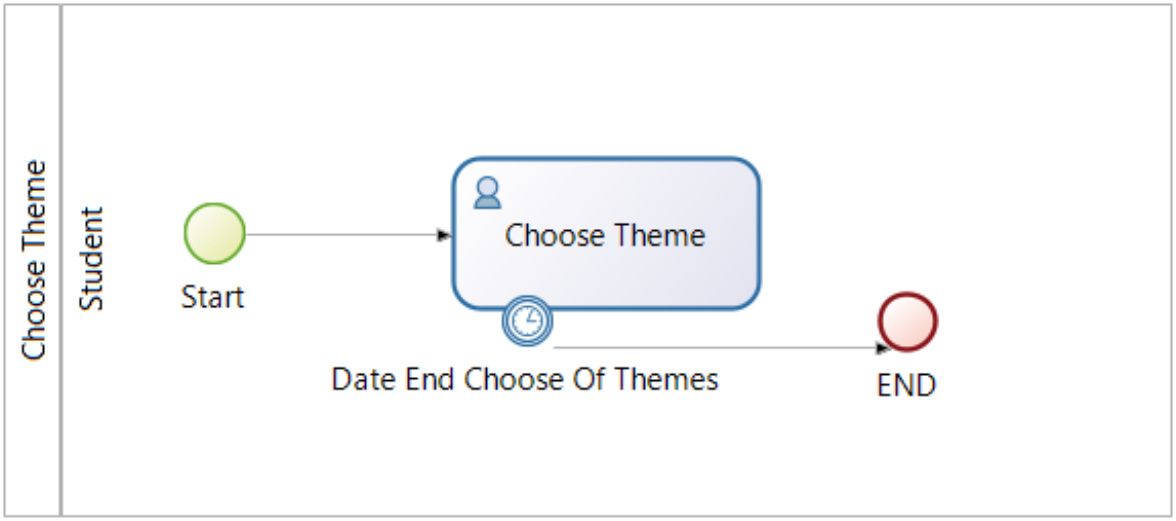


Figure 3.5: Theme Selection by Students.

3.5.5 Assignment of Themes by Teachers and Displaying the Final Assignment List to Students

Assignment of Themes by Teachers:

- After students have selected their preferred themes, teachers assign specific project themes.
- Assignments are based on criteria such as student skills, workload associated with the theme, and supervisor availability.

Displaying the Final Assignment List to Students:

- Once teachers complete the assignment process, the final list of theme assignments is made available to students.
- This list clearly shows each student their officially assigned project theme, ensuring transparency and clarity in the allocation process.

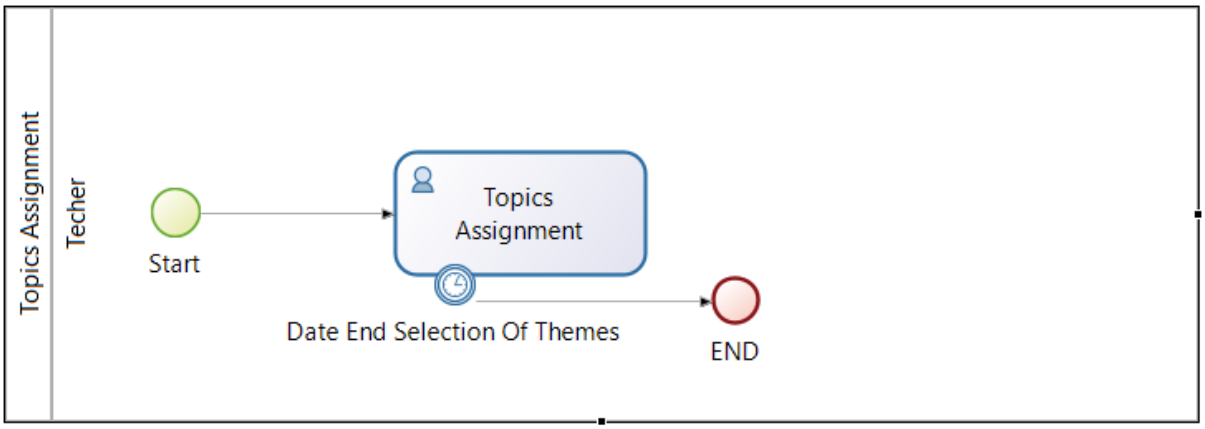


Figure 3.6: Assignment of Themes.

3.5.6 Academic Supervision

Students and Supervisors: The academic supervision process begins officially, with students meeting regularly with their assigned supervisors to discuss progress.

A work plan and schedule are established, detailing the project's key stages, deadlines, and regular meeting times.

Supervisors: Supervisors offer guidance and direction to students throughout the entire project lifecycle, spanning from research and planning to execution and analysis.

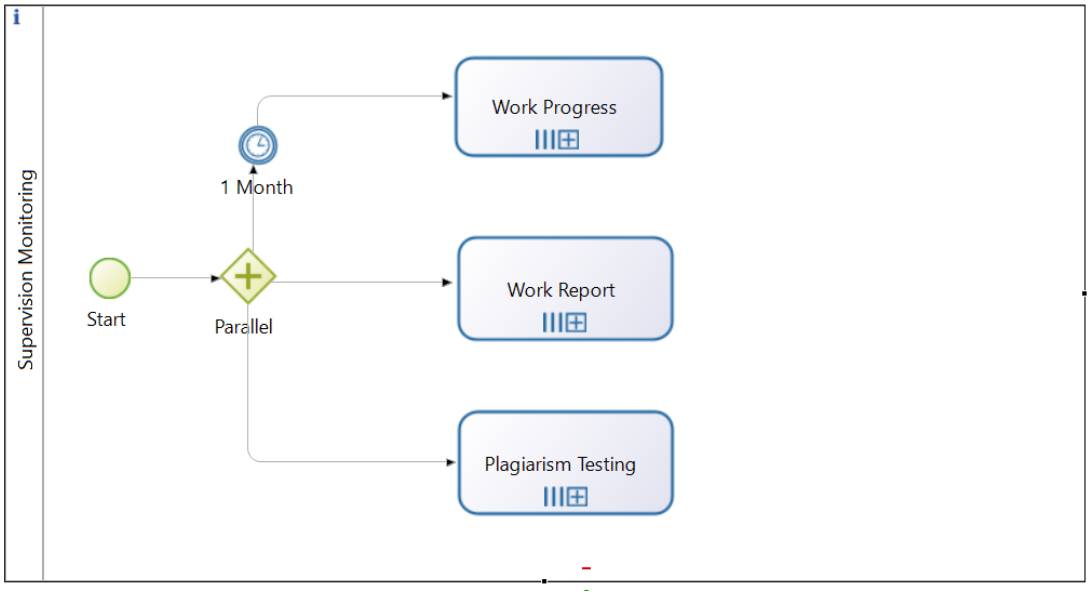


Figure 3.7: Academic Supervision.

3.5.7 Progress Monitoring

Department Head:

- Conducts regular meetings with supervisors to assess project progress.
- Prepares periodic reports summarizing each project's advancements, challenges encountered by students, and proposed solutions.

Supervisors: Submit regular progress reports on students' progress, participating in discussions on how to improve work quality and overcome obstacles.

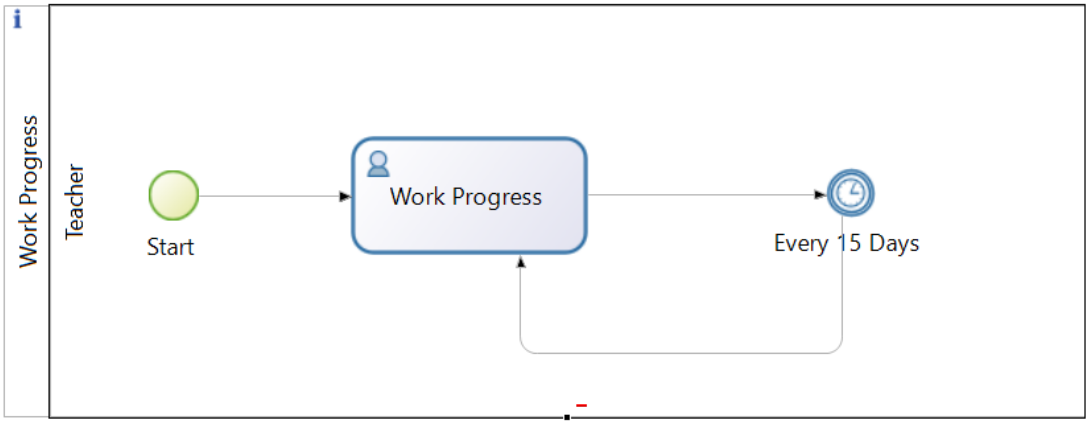


Figure 3.8: Progress Monitoring.

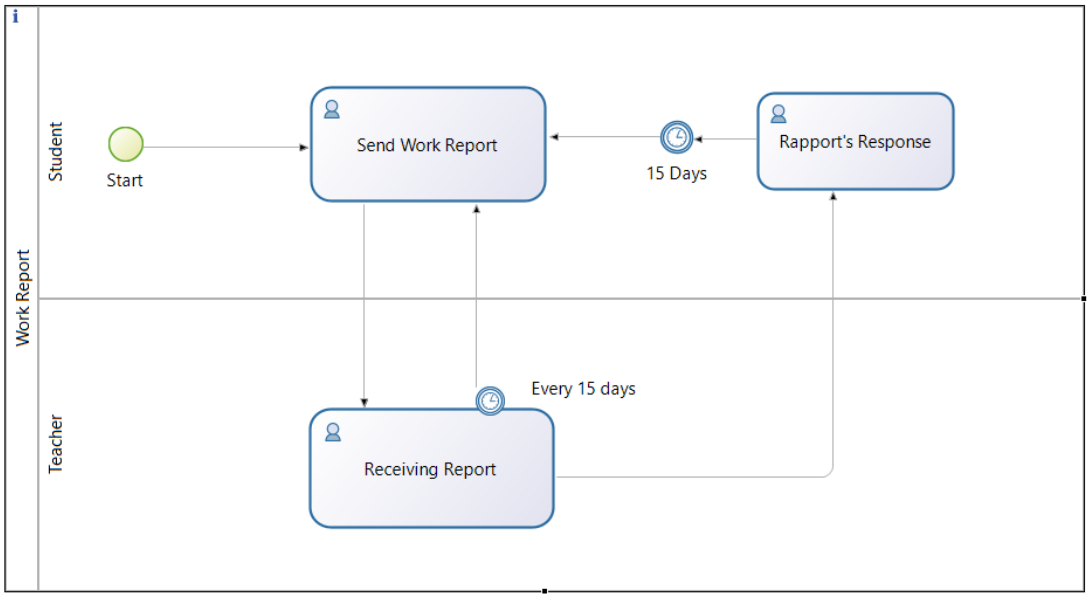


Figure 3.9: Progress Monitoring.

3.5.8 Report Submission and Plagiarism Check

Students: After completing the final report of the project, students submit it to the administration by the specified deadline.

Administration: Receives reports and sends them for plagiarism check.

Plagiarism Check: Reports are run through plagiarism detection software to verify the authenticity of the work and ensure no unauthorized copying or paraphrasing.

Reporting Results: Results of the plagiarism check are compiled into a report and communicated to students.

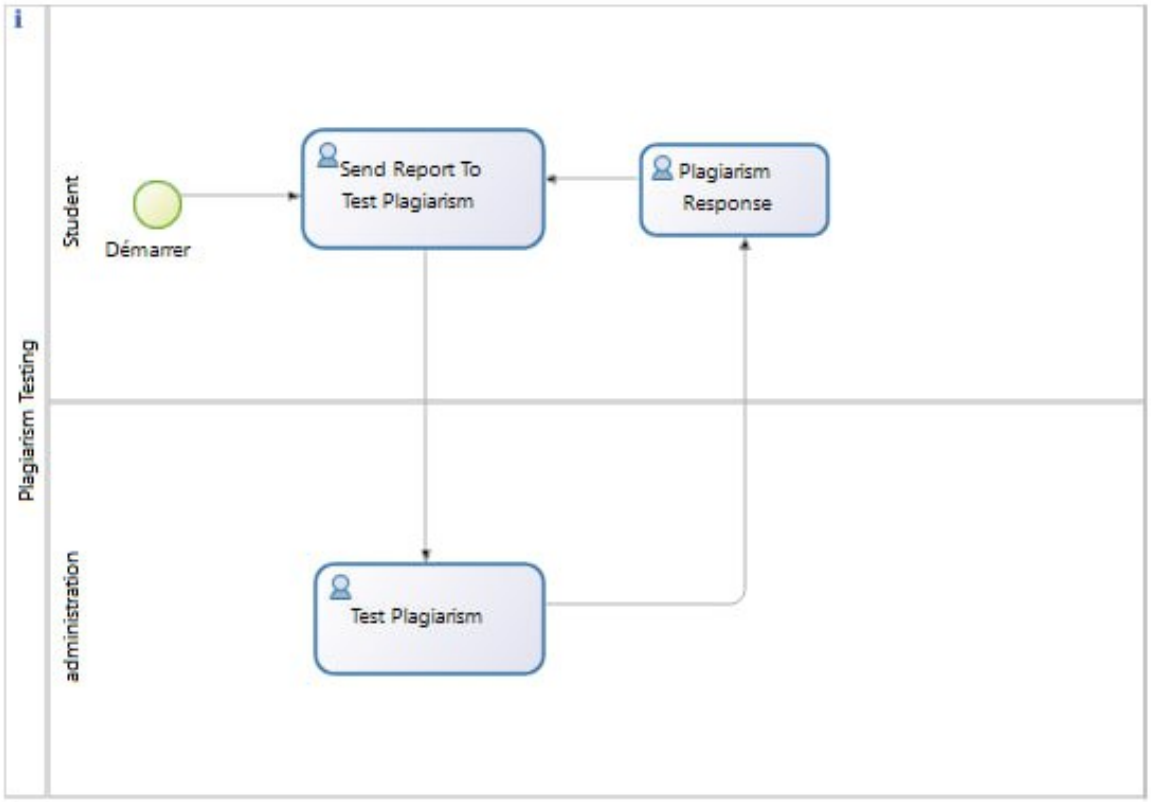


Figure 3.10: Plagiarism Check.

Resolution Process: If issues are identified, students are notified to revise the report and resubmit it accordingly.

After passing the plagiarism check, the student obtains approval from their supervisor to submit the final version of the report.

Once approved by the supervisor, the final report is submitted to the administration.

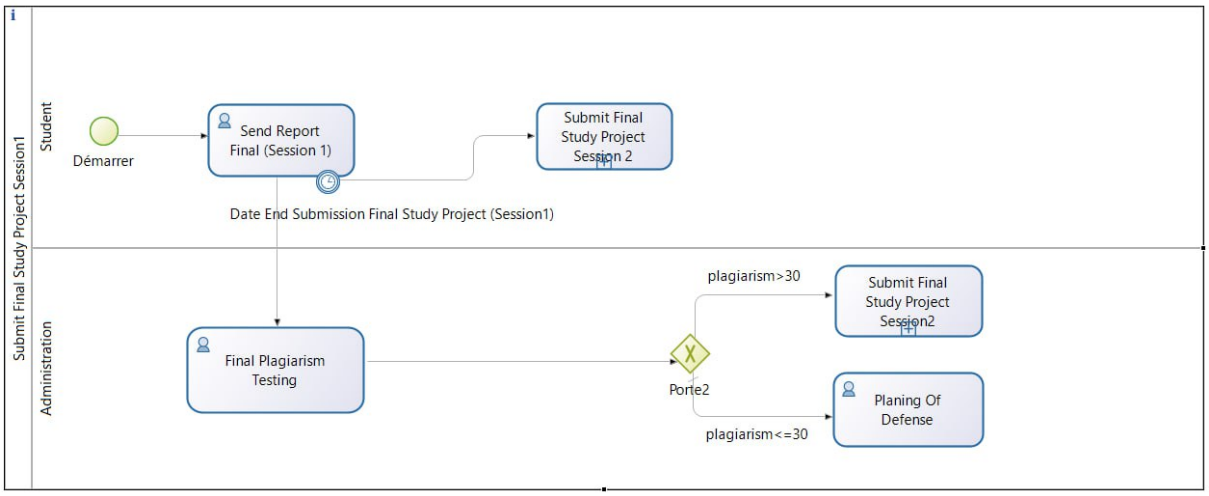


Figure 3.11: report submission session 1.

3.5.9 Remedial Work

Students Who Didn't Complete Reports or Failed Plagiarism Check: Students are informed of the check results and any issues found in their reports.

New Timeline: Students are provided with a specified additional timeframe to make necessary revisions and resubmit their reports.

Additional Support and Supervision: Additional guidance sessions may be offered to support students in making required revisions.

Resubmission and Plagiarism Check: After revisions, students resubmit their reports for another round of plagiarism checking.

Final Assessment: The revised report undergoes assessment, and if it meets all requirements, students proceed to the presentation and defense stage.

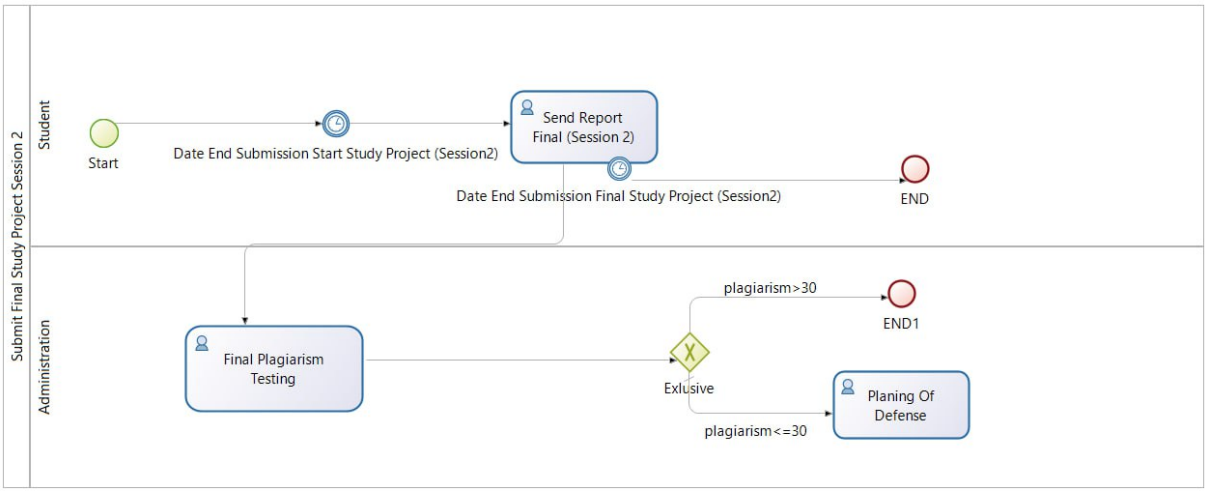


Figure 3.12: Remidial work.

3.6 Conclusion

This chapter provided a comprehensive overview of BPMN (Business Process Model and Notation) and its application in our project. We explored the basic concepts and key elements of BPMN, and presented BPMN diagrams that illustrate the workflow stages of our project. These diagrams will serve as the foundation for implementing efficient project management practices using BonitaSoft, enhancing transparency and effectiveness in academic operations.

Chapter 4

Implementation

4.1 Introduction

This chapter explores Bonita BPM, an open-source software tailored for managing academic processes within the Computer Science Department. We examine key components like the BPM engine, detailing how they streamline operations. Project-specific interfaces illustrate processes from initiation by department heads to student theme selection, academic supervision, and real-time progress monitoring. The chapter underscores Bonita's role in enhancing efficiency and transparency in academic management.

4.2 Presentation of the Open Source Software Bonita

Bonita is a platform for business process optimization and automation that is expandable and open-source. With distinct features for visual programming and scripting, the Bonita platform streamlines development and production. The graphical notation of BPMN, its complete extensibility, and its reusable components enable seamless communication between the various IT team profiles and with the business teams. In addition to orchestrating heterogeneous systems and integrating with current information systems, Bonita offers extensive visibility into organizational activities[14].

Furthermore, Bonita offers extensive visibility into organizational operations and connects with pre-existing information systems while orchestrating heterogeneous systems[14].

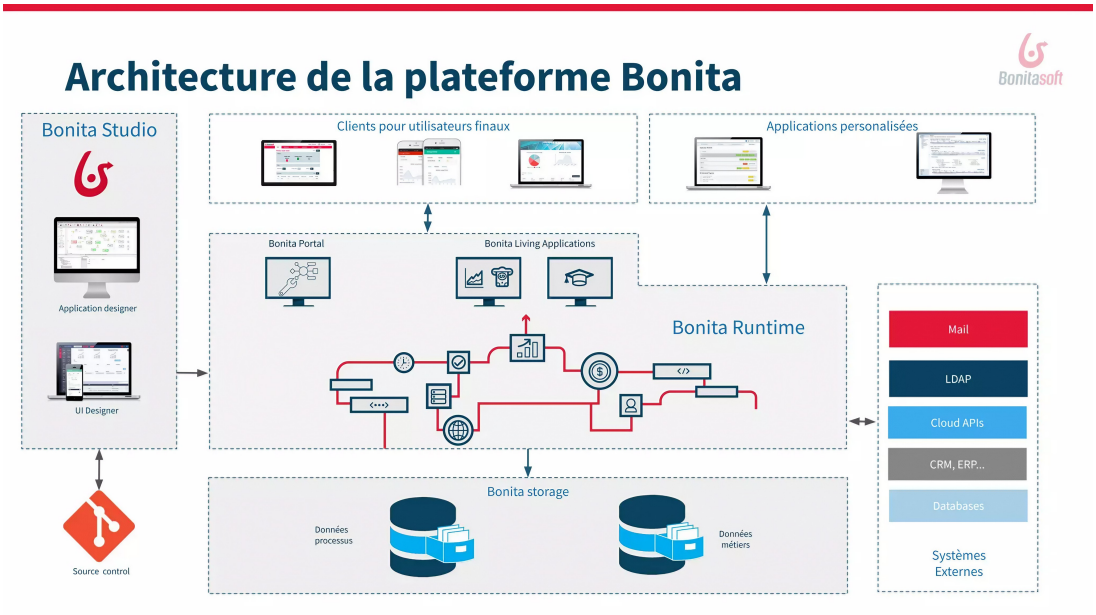


Figure 4.1: Bonita platform architecture.

4.2.1 Bonita Application Platform Components:

Bonita Studio

This tool allows users to graphically design professional processes compliant with BPMN standards. Users can integrate these processes with other information system components such as messaging, resource planning, business content management, and database management. This integration enables the creation of standalone business applications accessible via web forms. Bonita Studio also facilitates the graphical creation of forms for end-users to interact with the processes. It supports processes designed with other standards and technologies like XPDL or jBPM, and is built upon Eclipse [15].

4.2.2 Bonita BPM Engine

The Bonita BPM Engine is a Java application responsible for executing professional processes created using Bonita Studio [15].

4.2.3 Bonita Portal

Bonita Portal serves as a comprehensive platform for end users to manage their tasks and for process owners to administer and generate reports on processes. Built on AngularJS, it provides a user-friendly interface for interacting with Bonita workflows[15].

4.2.4 Bonita UI Designer

Bonita UI Designer provides a collection of pre-built features based on Bootstrap and AngularJS. It includes extension points allowing UI developers to integrate custom code, tools, frameworks, and graphical elements to create tailored user interfaces [15].

Bonita BPM is open-source and available for download under the GPL license.

4.3 The technical characteristics of Bonita BPM:

Bonita BPM adheres to standards established by the Workflow Management Coalition(WfMC), which aim to develop industry norms in workflow management in collaboration with key stakeholders. It integrates the XPDL language created by WfMC and utilizes on Java Enterprise Edition (JEE) technologies.

4.3.1 Java Enterprise Edition (J2EE):

Java Enterprise Edition, or JEE (formerly J2EE), is a specification for Sun's Java programming language, specifically tailored for enterprise applications. This specification extends the standard Java Framework (JSE, Java Standard Edition) to support the development of distributed applications. The term "J2EE platform" refers to the combination of services (APIs) it offers and the execution infrastructure.

Key components of J2EE include:

- **Application Server Specifications:** These define the runtime environment for J2EE applications, specifying roles, interfaces, and operational environments. This allows third-party developers to build compliant application servers without reimplementing core services.
- **API-based Services:** J2EE provides APIs that extend Java functionality, offering a standard set of features. The J2EE Software Development Kit (SDK) includes a minimal implementation of these APIs. Because J2EE is based on Java, it inherits Java's benefits, such as excellent code portability across different platforms.

4.3.2 XML Process Definition Language (XPDL):

XPDL, which stands for "XML Process Definition Language," is a standard developed by the Workflow Management Coalition (WfMC). It allows the definition of business processes or workflows using XML. These process definitions can then be executed by a workflow engine.

Key elements of a process definition in XPDL include:

- **Process Start and End Markers:** Define the beginning and completion points of the process.
- **Activities:** Tasks or steps within the process that need to be performed.
- **Transitions:** Define the flow or interactions between activities.
- **Attributes:** Specify behaviors associated with each activity.
- **Participant Roles/Groups:** Define roles or groups of participants involved in executing activities.
- **Interactions/Relations:** Describe interactions between participants and activities.

XPDL serves as a standard for seamlessly integrating heterogeneous workflow systems, ensuring interoperability across different platforms and tools.

4.4 Connectors Used in Bonita

Bonita employs Java-based connectors to enhance task capabilities within processes, facilitating interactions such as database queries and web service integrations. These connectors include defaults for various database management systems like Postgres, Access, MySQL, Oracle, and MS SQL Server. Additionally, Bonita supports Groovy and system script execution, SAP integration, and email sending capabilities.

Key Features:

- **Default Connectors:** Covering a wide range of database management systems and essential functionalities.
- **Custom Connector Development:** Bonita's process editor allows developers to create custom connectors using an integrated Java editor. These connectors can be exported and reused across different projects.
- **Community Contributions:** The Bonita community offers downloadable connectors for free, extending the platform's functionality.
- **Integration Flexibility:** Supports the integration of external libraries within processes, enhancing capabilities for Groovy scripting or custom connector usage.

For our project, we have utilized integrated email services for communication purposes, and employed Groovy for scripting tasks within our processes.

4.5 Presentation of some interfaces of our project

4.5.1 Bonita Portal:

Through this interface below 4.2, the user can access by entering his username and password .

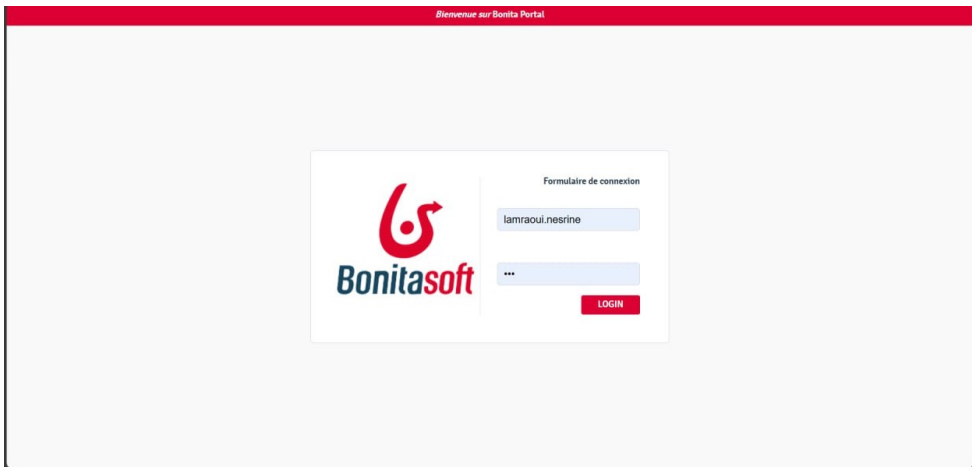


Figure 4.2: The Bonita portal.

4.5.2 The head of departement initialize the process

This interface represents the department head started the Final Study Project process 4.3.

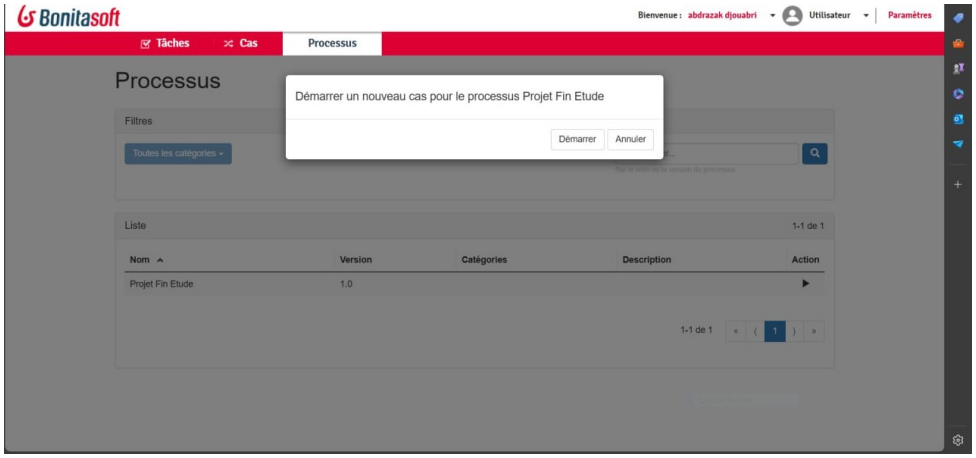


Figure 4.3: Start the process.

4.5.3 Department Head Entering Information

The head of the department enters the information focused on in the Final Study project process 4.6.

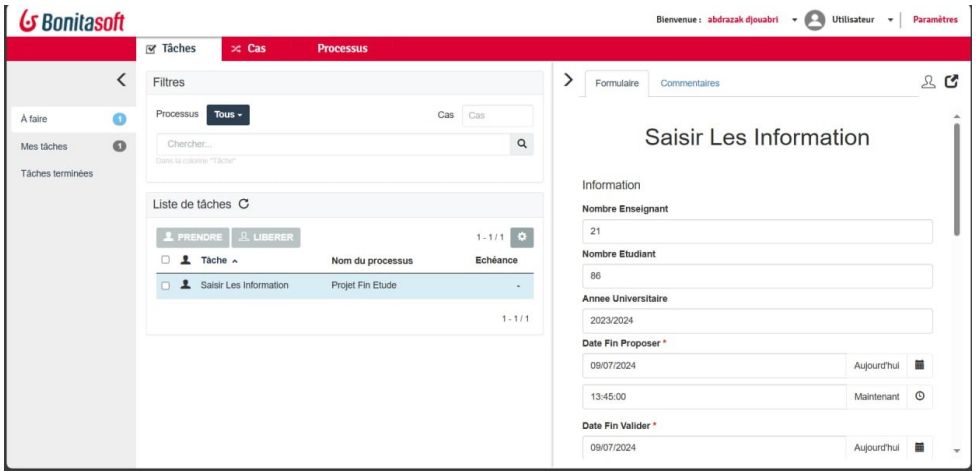


Figure 4.4: Entering Information.

4.5.4 Email Notification

This figure 4.6 shows automatic email notifications are sent to all teachers about deadlines and steps involved in the graduation project management process.

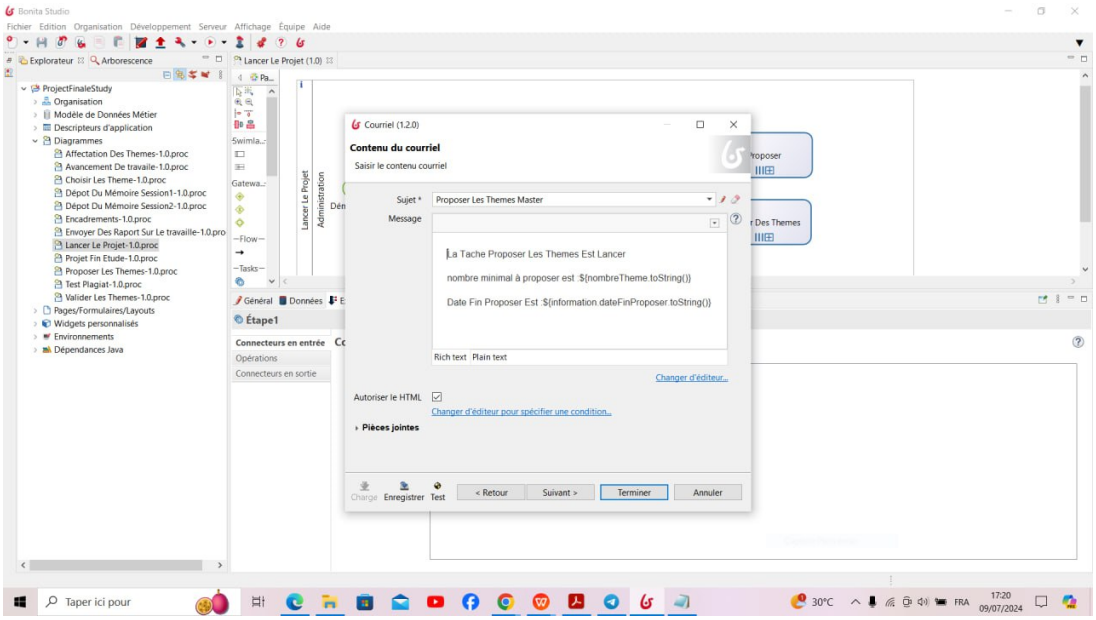


Figure 4.5: Configuration of Email Conector.

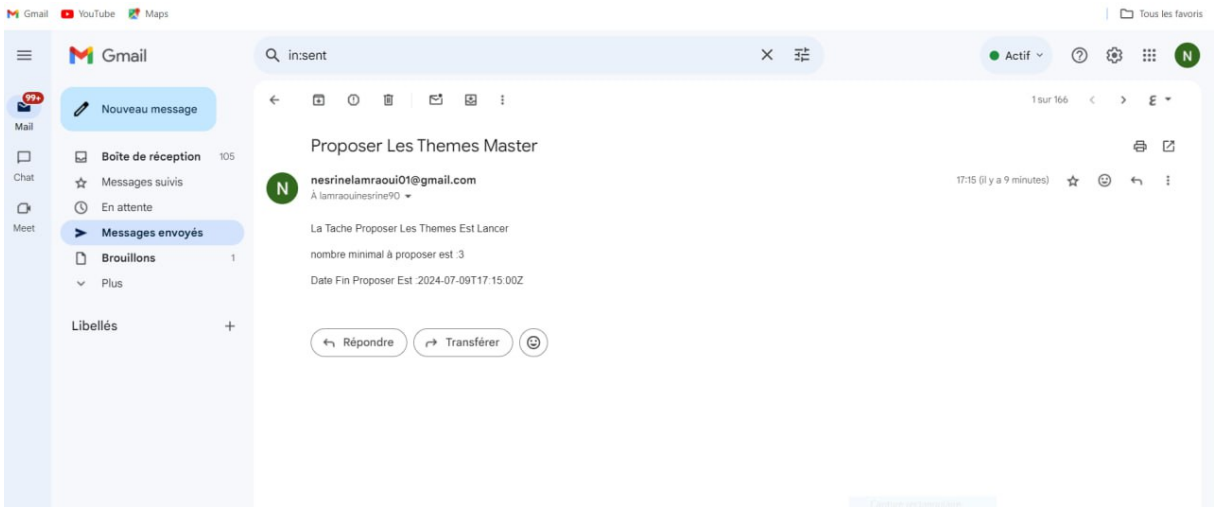


Figure 4.6: Receive Email .

4.5.5 Proposing of topics by professors

The following interface 4.7 shows Professors submit topics within their expertise using a specific form that includes the topic title, description, objectives, and methodology.

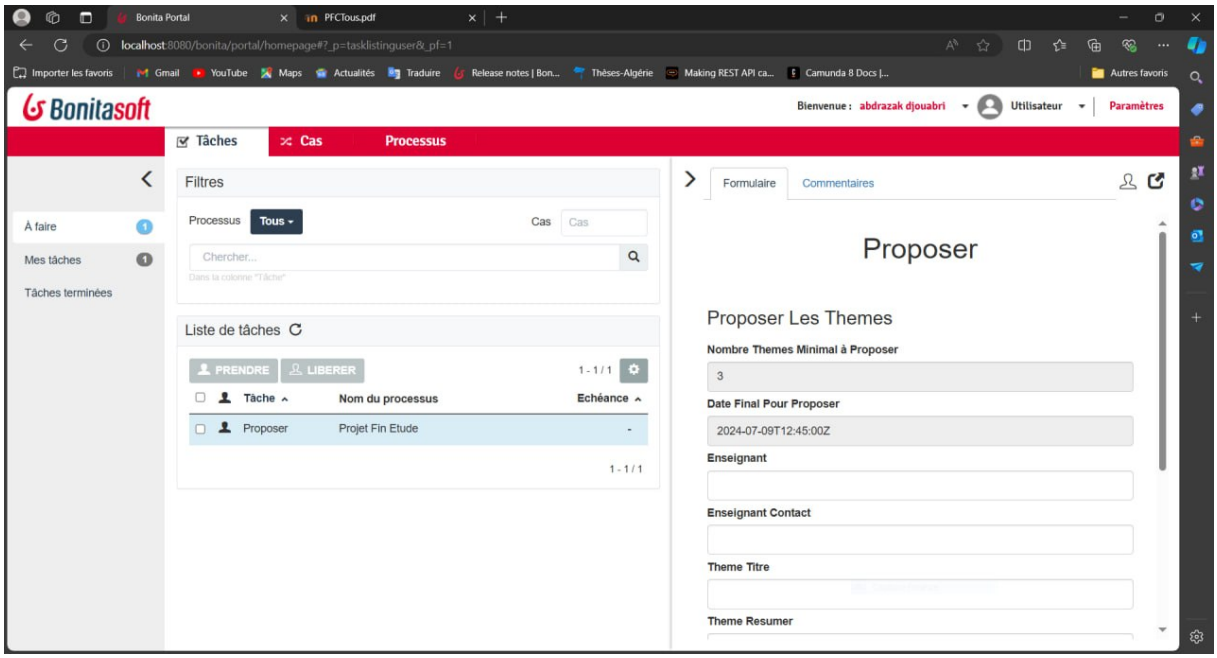


Figure 4.7: Proposing of topics by professors.

4.5.6 Validation of Themes by the CSD.

The following figure 4.8shows,the Department Scientific Committee (CSD) reviews and validates the proposed themes to ensure relevance and academic standards.

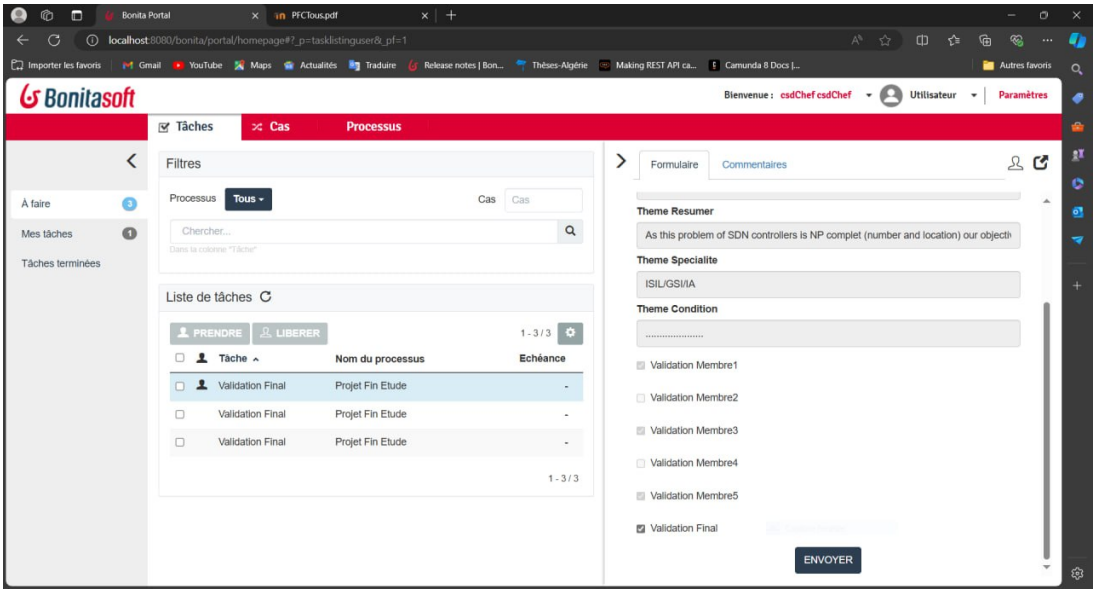


Figure 4.8: Validation of Themes by the CSD.

4.5.7 Theme Selection by Students

Students review the proposed topics and choose those that correspond to their interests and academic goals 4.19.

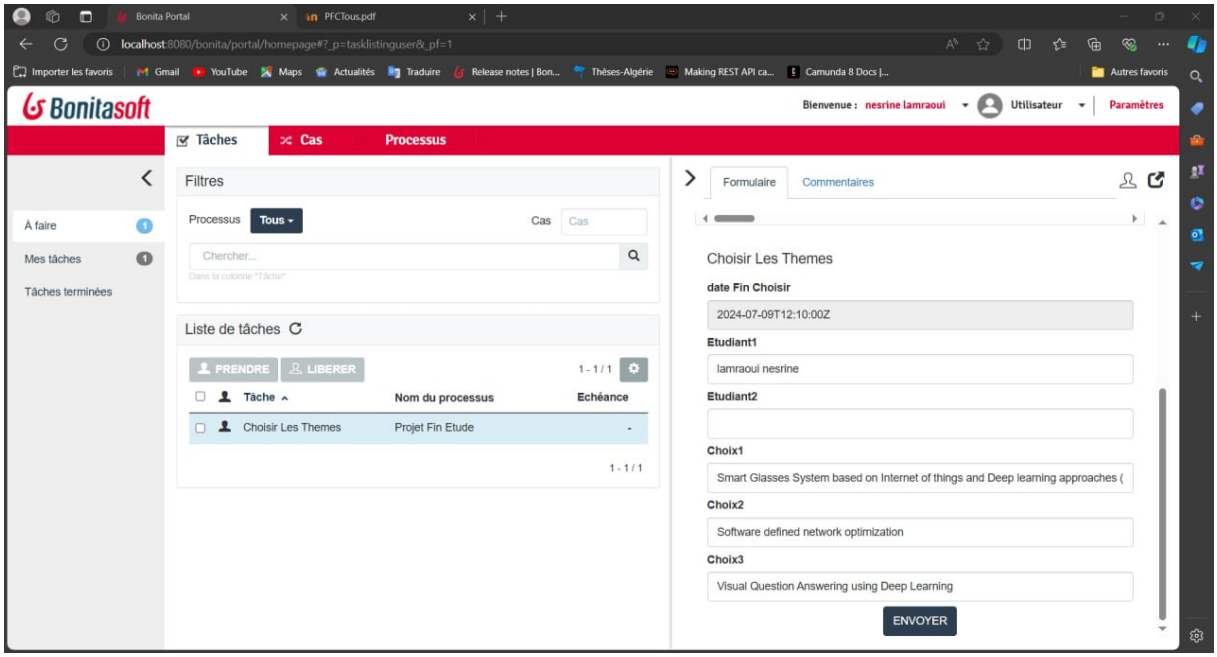


Figure 4.9: Theme Selection by Students.

4.5.8 Assignments of Themes

This interface 4.10 shows teachers who assign subjects based on criteria.

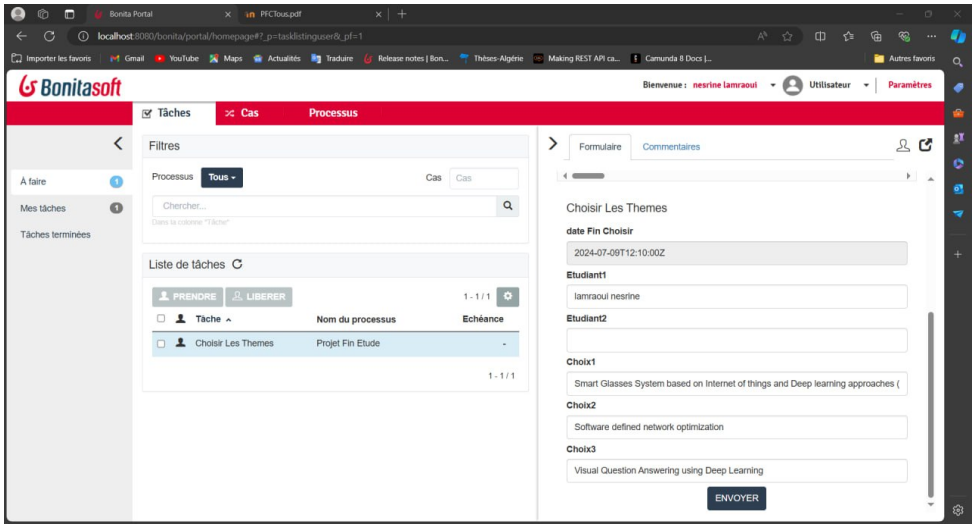


Figure 4.10: Assignments of Themes.

4.5.9 Academic Supervision.

The supervision process consists in communication between the supervising teacher and the student by sending the work plan and the work report, for example .And every supervising teacher and the way he works 4.11.

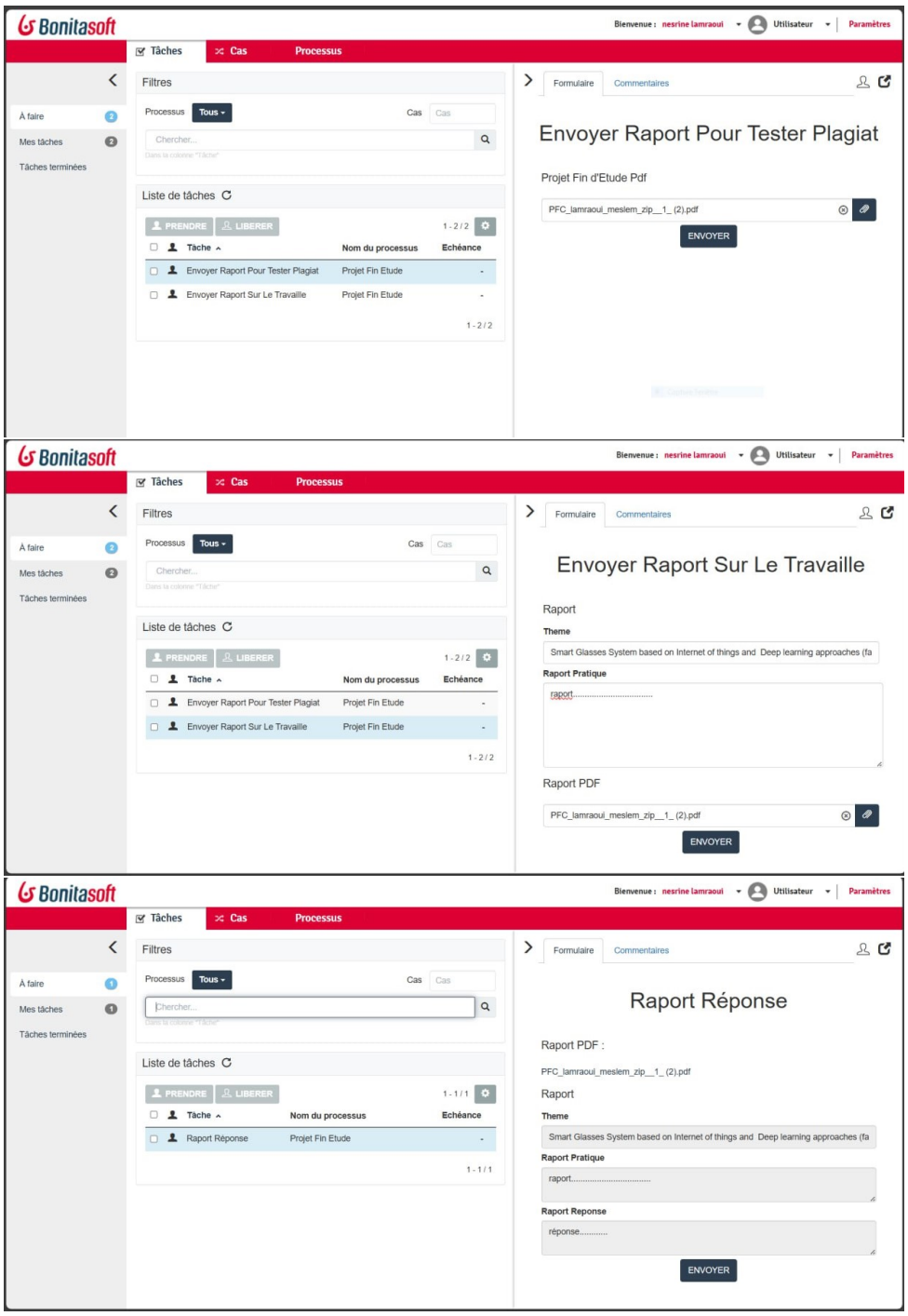


Figure 4.11: Academic Supervision.

4.5.10 Progress Monitoring

Supervisors submit regular progress reports, and periodic reports summarize each project's advancements and challenges 4.12.

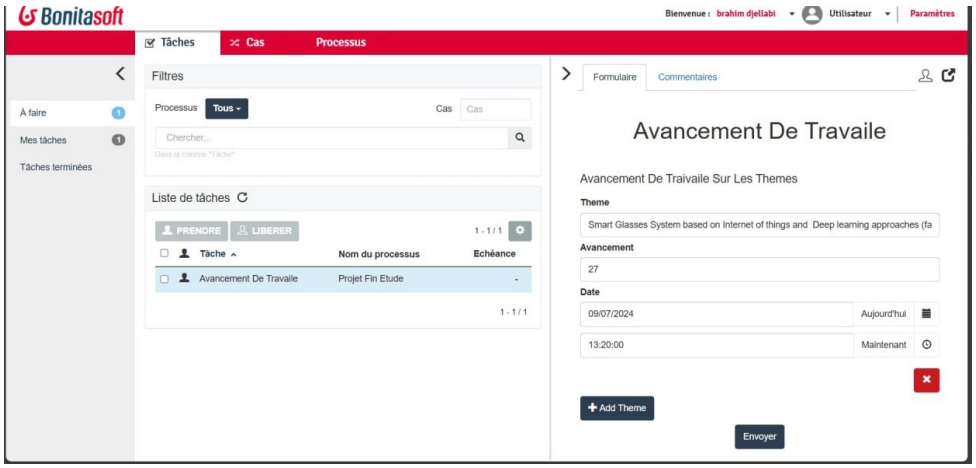


Figure 4.12: Progress Monitoring.

4.5.11 Report Submission and Plagiarism Check

This figure4.13 represent the Students submit their final reports, which are then checked for plagiarism.

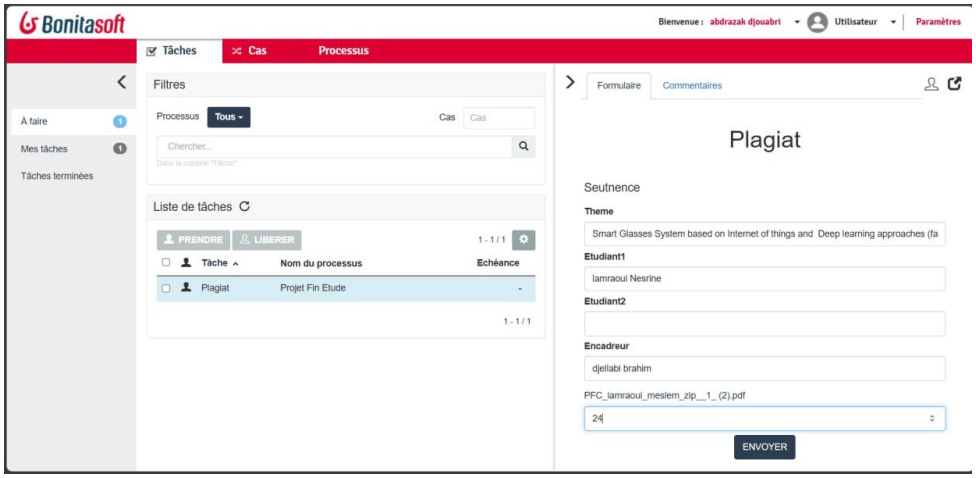


Figure 4.13: Plagiarism Check.

After reporting the results of plagiarism and after processing the errors, they are approved by the supervisor and then submitted in session 1 4.14.

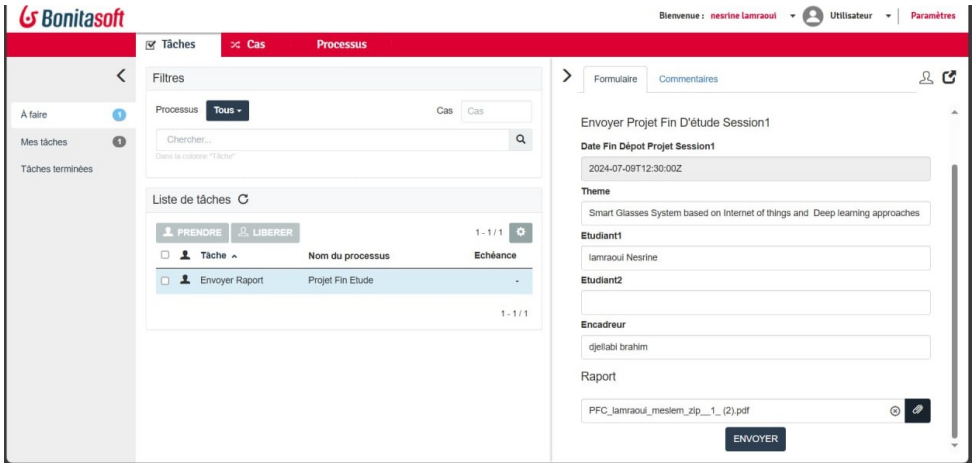


Figure 4.14: Report Submission.

4.5.12 Defense Plan

This interface 4.6 shows that the head of department communicates the program with students and teachers.

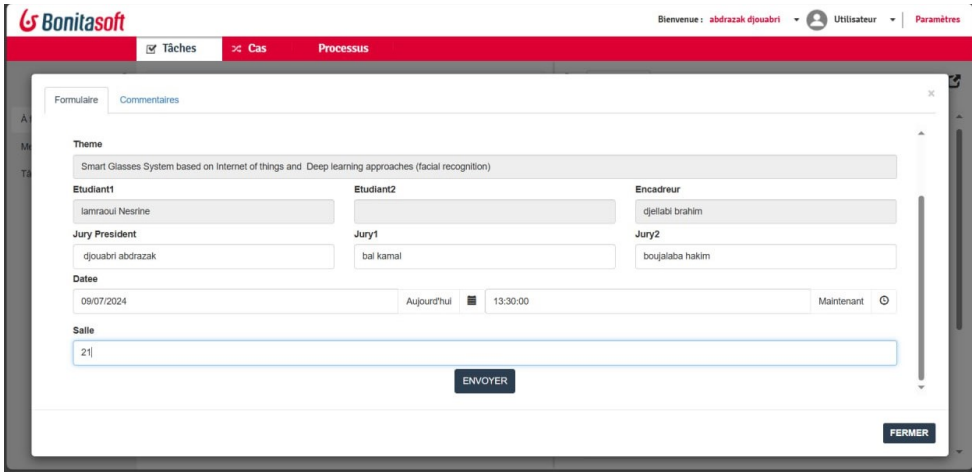


Figure 4.15: Defense Plan.

4.6 Living Application Bonita

A Living Application is a set of pages that a Profile can navigate through. It is developed and managed within the Bonita Platform using Bonita Studio and UI Designer, Bonita Continuous Delivery for deployment, and Bonita Runtime for operation [2].

4.6.1 Administration Space

The administration space contains several interfaces such as this figures 4.17 and 4.20

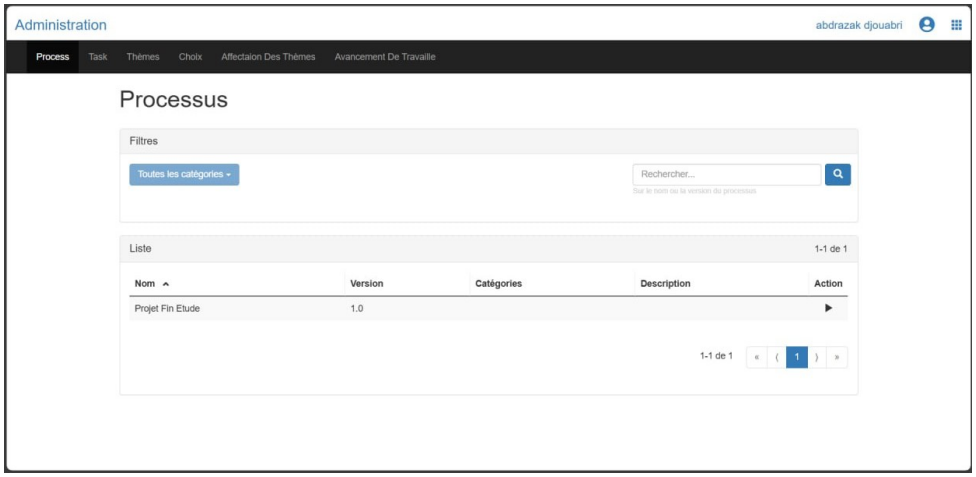


Figure 4.16: Page of Process.

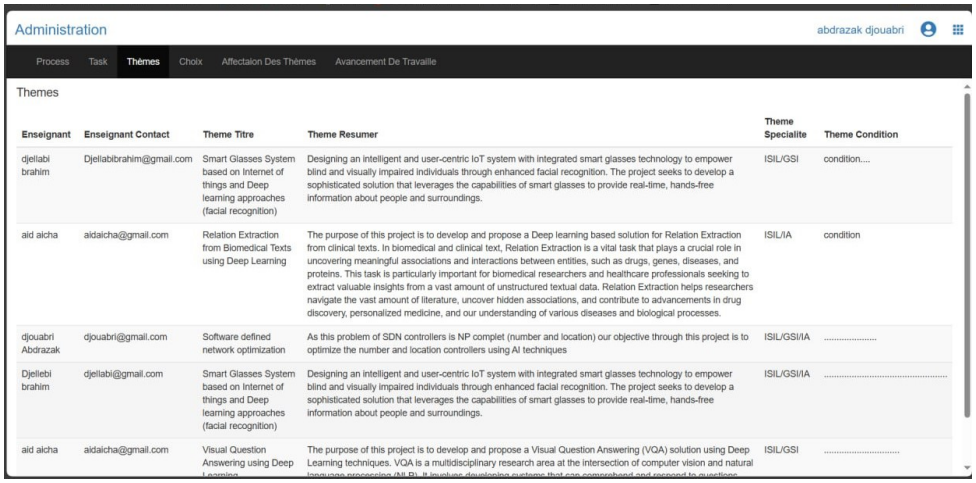


Figure 4.17: The Themes Page .

4.6.2 Teachers Space

Teachers can see the proposed subjects and the defense plan 4.18 and the assignments of the themes 4.18.

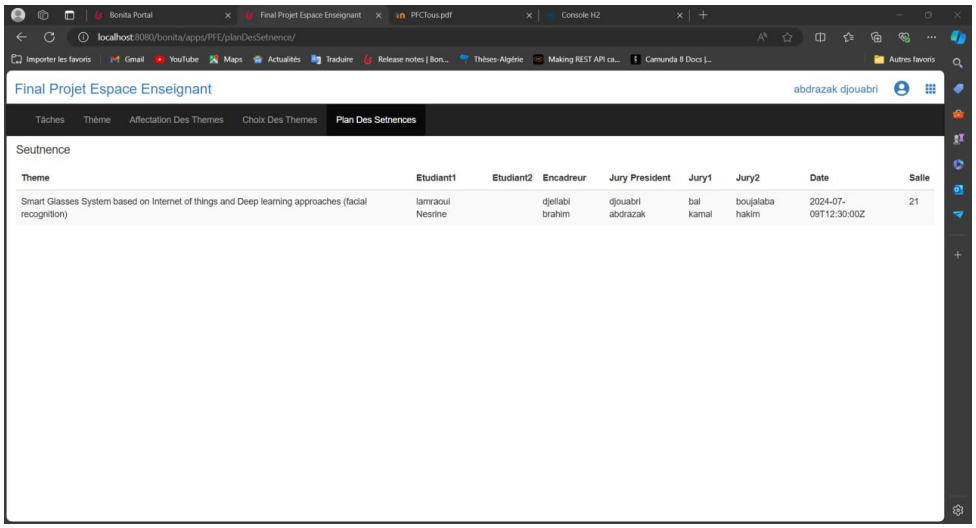


Figure 4.18: Defense Plan.

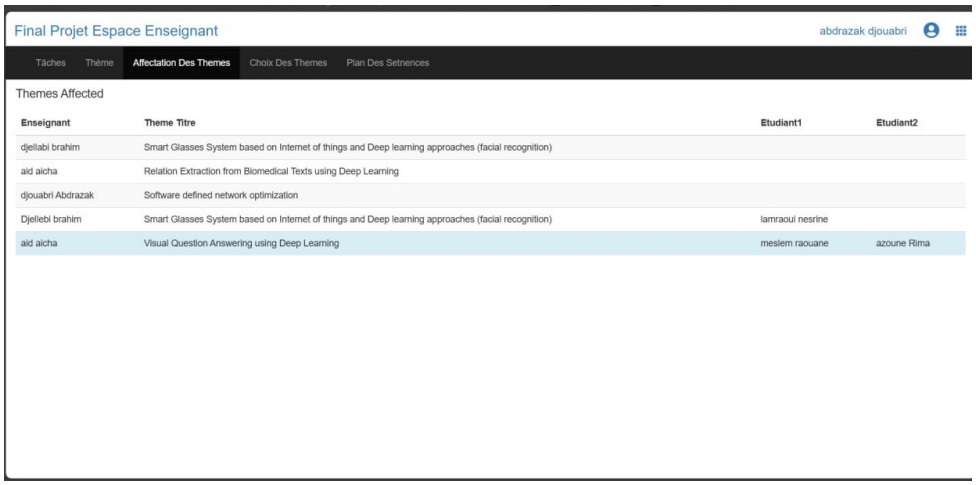


Figure 4.19: Assignment of Themes .

4.6.3 Students Space

The Students Space contains several interfaces such as this interface below 4.20.

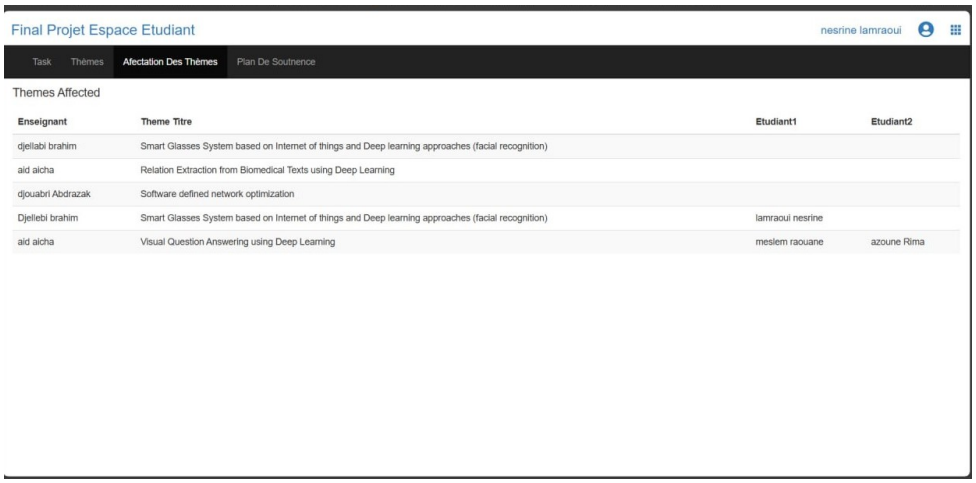


Figure 4.20: Assignment of Ahemes for Students .

4.6.4 CSD Space

CSD can only validates the topics proposed by the teachers 4.21.

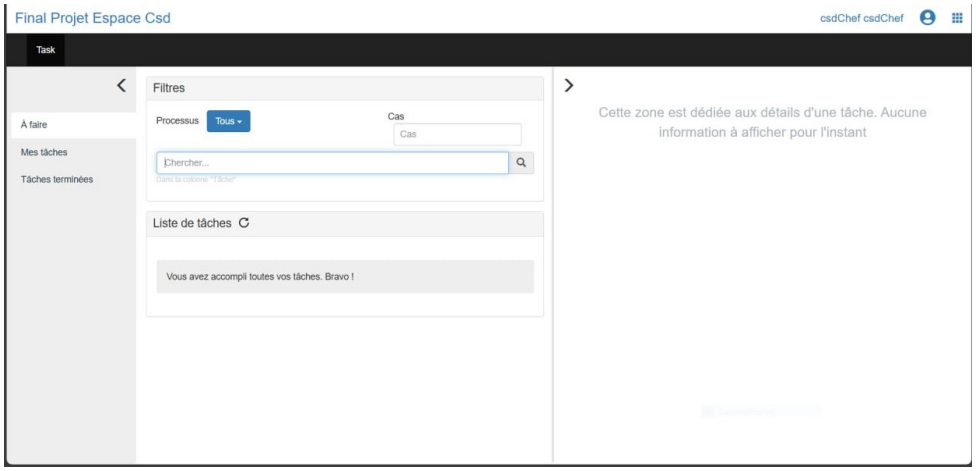


Figure 4.21: CSD Space .

4.7 Conclusion

In this final chapter, we explored Bonita, an open-source platform for Business Process Management (BPM). We introduced its core components, demonstrating how they collaborate to automate and optimize processes. We also discussed its technical characteristics. By showcasing specific interfaces and workflows, we highlighted Bonita's practical application in managing academic processes, confirming its effectiveness and efficiency in business process management.

General conclusion

This thesis represents an exceptional effort in the development and enhancement of academic processes within the Computer Science department. Focused on designing and implementing a system that leverages cutting-edge project management technologies, the thesis aims to streamline and improve the management of final study projects, enhancing their effectiveness and quality.

The thesis begins with an introductory overview of the department and the university, highlighting current administrative challenges facing academic operations. It proposes solutions and outlines the objectives of the proposed project. Additionally, the thesis delves into a thorough study of workflow management concepts and systems, presenting a BPMN design proposal for practical implementation using the Bonita BPM platform.

The proposed design for managing final study projects marks a pivotal step towards achieving departmental goals by fostering collaboration, improving administrative efficiency, and enhancing the experience of students and faculty members alike. This system represents a strategic addition aimed at fostering innovation and excellence within the department, with potential for broad application to achieve efficiency and effectiveness in academic operations.

In conclusion, the comprehensive workflow management system represents a significant step towards achieving our goals and enhancing the academic experience within the Computer Science department. We look forward with confidence to its implementation, expecting it to set new standards for administrative efficiency and operational excellence in academic environments.

Bibliography

[1] Rafael Ferreira da Silva, Rosa Filgueira, Ilia Pietri, Ming Jiang, Rizos Sakellariou, and Ewa Deelman. A characterization of workflow management systems for extreme-scale applications. pages 4–6, 2017.

[2] BonitaSoft. $bpmn2_l essentiel_e dition_0 61017.2016$.

[3] Hayat BENDOUKHA. *Business Process Management & Workflow*. 2023. Département d'Informatique Faculté des Mathématiques et Informatique USTO-MB - Oran Septembre 2023. [Polycopié du cours].

[4] Djalabi Brahim. *WRKFLOW Basics*. 2024. [Cours PDF].

[5] Université de Bouira. Page d'accueil. `https://www.univ-bouira.dz/fr/?page_id=2147001`, 2024. [Visit the 06/05/2024].

[6] Ministry of Higher Education and Scientific Research. Site officiel. `https://www.mesrs.dz/index.php/fr/progres/`, 2024. [Visit the 06/05/2024].

[7] The Workflow Management Coalition. Workflow management coalition terminology and glossary. Technical Report WfMC-TC-1011, 1999.

[8] Yasmina FERHAOUI and Djamila LAIB. Création et implémentation d'une application workflow sous bonita open source. cas : Le suivi administratif du dossier malade au niveau de l'hôpital chu-to (service pédiatrie ii). Master's thesis, Mémoire de Fin d'Etudes de MASTER ACADEMIQUE, Domaine : Mathématiques et Informatique Filière : Informatique, Spécialité : Chef de projet informatique, 2016.

[9] Lotfi BOUZGUENDA. *Coordination Multi-Agents pour Interorganisationnel Lâche*. PhD thesis, Université Toulouse, 2005.

[10] Luzardo P Silva and Francisco AC Pinheiro. Eliciting requirements for identifying workflow categories. 2003.

[11] Moteur de workflow. `https://fr.wikipedia.org/wiki/Moteur_de_workflow`, 2024. [Visiter le 06/05/2024].

[12] Djohar MEBKHOUT and Nouzha TERCHOUNE. Approche multi-agent pour la conception d'un workflow coopératif et administratif. Master's thesis, Université IBN KHALDOUN– Tiaret, Département d'Informatique, 2016/2017.

[13] Thomas Vantroys and Yvan Peter. Un système de workflows flexible pour la formation ouverte et à distance. in technologies de l'information et de la communication dans les enseignements d'ingénieurs et dans l'industrie, pages 97–104. Institut National des Sciences Appliquées de Lyon 2002.

[14] Bonitasoft documentation. `https://documentation.bonitasoft.com`, 2024. [Visit the 02/07/2024].

[15] Bonita bpm. `https://en.wikipedia.org/wiki/Bonita_BPM`, 2024. [Visit the 02/07/2024].

[16] Mark Von Rosing, Stephen White, Fred Cummins, and Henk De Man. Business process model and notation-bpmn, 2015.

[17] Thomas Vantroys and Yvan Peter. Un système de workflows flexible pour la formation ouverte et à distance. In *Technologies de l'Information et de la Communication dans les Enseignements d'ingénieurs et dans l'industrie*, pages 97–104. Institut National des Sciences Appliquées de Lyon, 2002.

[18] Levan Serge. *Le projet workflow : concepts et outils au service des organisations*. Eyrolles, 1999.