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Digitalization and Optimization of University Business Processes through BPM and KPI Integration

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ARTICLE INFO	ABSTRACT
	Introduction: The digitalization of business processes has become a necessity for organizations to enhance their efficiency and productivity. Higher education institutions, in particular, are increasingly turning to digital solutions to streamline administrative operations and improve service delivery to students. **Objective:** This study aims to digitalize and improve the business processes of the university by leveraging Business Process Management (BPM) mechanisms and new technologies. The primary focus is on optimizing student support processes to enhance efficiency, reduce administrative delays, and improve communication between students and academic staff. **Methods:** This research follows a structured approach that includes: First, Business Process Analysis and Design – Identifying users, tasks, and all relevant process elements to design an optimized student support process. Second, Integration of KPIs in BPM – Incorporating Key Performance Indicators (KPIs) into digitalized business processes to improve performance and quality within the digital transformation framework. **Results:** The paper presents the development of BP-KPI, a solution that integrates BPM and KPIs to automate and enhance student support at Oran University of Science and Technology Mohamed-Boudiaf (USTO). The BP-KPI platform offers functionalities such as automated task assignment, real-time progress tracking, and personalized notifications for students. **Discussion:** By streamlining student support processes, the proposed solution minimizes administrative delays, improves resource allocation, and fosters efficient communication between students and academic authorities. The integration of BPM and KPIs demonstrates strong potential in addressing challenges within student services. Furthermore, the BP-KPI framework offers a scalable model for digital transformation in higher education, contributing to enhanced institutional efficiency, personalized student assistance, and data-driven decision-making. **Keywords:** BPM, Business Processes, Modeling, Digitalization, JBPM, KPIs.

INTRODUCTION

Due to their importance, companies have increasingly focused on optimizing a wide range of activities. Moreover, they are compelled to communicate more effectively with their customers, partners, suppliers, and subsidiaries to achieve faster and more cost-effective production. To meet these demands, businesses rely on various business processes—interconnected activities designed to achieve specific goals, typically within an organizational framework that defines roles and relationships (Hammer & Champy, 1993).

It is essential to have a comprehensive and enhanced vision of all business processes and their interactions to optimize and automate them as much as possible. This necessity has given rise to the field of Business Process Management (BPM), a structured approach encompassing the modeling, digitalization, execution, administration,

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and optimization of business processes (Davenport, 2005). Studies such as van der Aalst (2013) emphasize the importance of process mining and business process modeling to achieve efficiency in organizations.

Companies face significant challenges in managing business processes, while employees require digital tools to fully leverage process potential and efficiently accomplish their tasks. As a result, BPM has become a dominant technology in modern enterprise systems. Furthermore, the digitalization of business processes has become an unavoidable trend, offering numerous benefits and opening new opportunities for operational efficiency and organizational competitiveness (Rosemann & vom Brocke, 2015).

The digitalization of business processes has become a strategic priority for organizations in the era of digital transformation. Rapid technological advancements and the increasing demand for operational efficiency have driven companies to rethink their traditional work methods. Business process digitalization aims to automate workflows, reduce costs, enhance product and service quality, and improve customer satisfaction. As noted by vom Brocke et al. (2014), leveraging BPM with data analytics can enhance service quality and process adaptability, making it a crucial component of digital transformation strategies.

Context and Objectives

This study addresses this gap by offering a novel perspective on the impact of digitalization on university business processes. Specifically, the research focus on the development and digitalization of the student support process throughout their academic journey. This research provides an in-depth analysis of this process, identifying key stakeholders, challenges, and objectives. The primary goal of this solution is to improve the student experience and foster academic success by optimizing student support processes at Oran University of Science and Technology Mohamed-Boudiaf (USTO).

Additionally, the research explores how Key Performance Indicators (KPIs) can be integrated into the digitalization of business processes. For instance, a relevant KPI for student support could be "average response time to student inquiries," which measures the efficiency and speed of interactions between students and university services. Finally, this paper discusses the key challenges and considerations associated with this digital transformation.

I.   A Literature Review of Key Approaches

The digitization of business processes is essential for organizations aiming to improve operational efficiency and stay competitive. This section reviews research on different technologies and approaches, discussing their roles and challenges in digitalizing business operations.

▪ Robotic Process Automation (RPA)

Van der Aalst, Bichler, and Heinzl (2018) explore the role of Robotic Process Automation (RPA) in business process digitization. RPA automates repetitive, rule-based tasks using software robots or "bots." These bots enhance efficiency, reduce costs, and improve accuracy. However, challenges include selecting appropriate processes for automation, managing organizational change, and securing sensitive data. The authors offer strategies to overcome these obstacles and maximize RPA's potential.

▪ Exploiting the Digitalization Potential of Business Processes

Denner, Püschel, and Röglinger (2020) focus on process improvement within the Business Process Management (BPM) lifecycle. They discuss the challenges organizations face when integrating digital technologies and propose a method to harness the digitalization potential. Their research, developed through action research with practitioners and end-users, demonstrates the method's effectiveness, including a case study from a semiconductor manufacturing company.

▪ Cloud Computing in Digital Transformation

Marston, Li, Bandyopadhyay, and Zhang (2020) investigate the role of cloud computing in digital transformation. Cloud computing enables scalability, automation, and cost-efficient models, facilitating growth and profitability. The article emphasizes the importance of aligning business, legal, and security considerations during cloud adoption and highlights the role of technical and financial support to ensure success.

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- ▪ **Digitalization and the Role of Management Controllers**

Ross, Beath, and Sebastian (2017) examine how digitalization, driven by Big Data and AI, is reshaping business operations. The paper discusses how digital transformation enhances responsiveness to customer needs and drives innovation. It also highlights the role of ERP systems and the impact of Big Data on management control systems, influencing how businesses assess customer satisfaction, employee engagement, and managerial performance.

- ▪ **IoT and Big Data as Drivers of Digitalization**

Rajan and Agarwal (2022) explore how the Internet of Things (IoT) and Big Data contribute to digitalization strategies. They find that IoT and Big Data are crucial in reconfiguring business processes and services, although adoption is inconsistent. Challenges include security, organizational culture, and knowledge management. The authors emphasize the positive impact of these technologies on business transformation and offer recommendations for managers and marketers.

Choice of BPM Technology

the research has chosen to use BPM (Business Process Management) for the digitalization of our business process. BPM is a methodological and technological approach aimed at modeling, automating, executing, monitoring, and optimizing the business processes of an organization.

By opting for BPM, our goal is to enhance the operational efficiency of our business process, reduce errors and delays, and increase transparency and traceability of activities. BPM was specifically chosen due to its scalability and integration capabilities with existing IT infrastructure, making it an ideal solution for organizations looking to optimize their workflows. Additionally, BPM's ability to handle complex workflows, both simple and highly intricate, ensures its effectiveness in improving business operations.

Using BPM, This research aims to graphically model our business process, implement it through software automation, and monitor it in real-time. This will allow us to not only optimize workflows but also monitor progress continuously. Real-time monitoring ensures that bottlenecks and inefficiencies are identified swiftly, allowing us to make informed decisions promptly.

In addition, BPM allows for the collection and analysis of performance data, which will be crucial for continuous improvement. By measuring process performance, this research can identify areas of improvement, streamline operations, and make data-driven decisions. This is where KPIs come into play, helping us measure our progress and pinpoint specific areas requiring attention.

For instance, this study plans to track KPIs such as process cycle time, error rates, and customer satisfaction. These indicators will allow us to assess the effectiveness of the process and identify any issues promptly. The integration of BPM with KPI measurement tools will provide a clear and real-time overview of performance, contributing to a more agile and responsive operation. the use of BPM in our work will transform our existing business process into a digitalized, automated, and optimized process. By doing so, it will contribute to improving the efficiency and quality of our organization, providing us with the tools to continuously monitor and improve performance.

KPIs – Key Performance Indicators

KPI stands for Key Performance Indicator. KPIs are quantifiable measures used to evaluate the performance of a business in order to assess its progress toward set goals. They provide valuable insights for making informed decisions, identifying strengths and weaknesses, and implementing corrective actions. KPIs will enable us to continuously track the progress of our digitalized process, ensuring that the research remains on track to achieve our strategic objectives.

This research aims to measure metrics such as process cycle time, customer satisfaction, and error rates. These KPIs will help us understand the efficiency of our BPM implementation and offer insights into areas that need improvement. Moreover, the use of BPM software will allow us to track these KPIs in real time, providing immediate feedback on the effectiveness of any changes the research makes.

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II.   Methodology: Proof of Concept for Business Process Digitalization

The objective of this study is to conduct an in-depth analysis of the key business processes within the university and assess how digitalization can provide tangible benefits. By examining the various stages of these processes, The research aims to identify bottlenecks, inefficiencies, and opportunities for improvement. the research will also explore the digitalization technologies available in the market, focusing on their applicability and relevance to the university.

Through a methodical approach, This research aims to provide specific recommendations for the digitalization of the university's business processes. These recommendations will be based on empirical data, comparative analyses, as well as best practices from academic literature and industry. A comprehensive study will be conducted to select the right tool and maximize the benefits of this emerging trend. Selection criteria include compatibility with existing systems, ease of integration, scalability, cost, and effectiveness in managing digital processes specific to the university.

- **Design**

In this part of this paper , This research aims to present the design of the business process for supporting the student in their education using JBPM.

Overview of JBPM

jBPM, which stands for Java Business Process Management, is an open-source framework for business process management (BPM) developed in Java. It provides a complete environment to model, execute, and monitor business processes within an organization. The main goal of jBPM is to automate and streamline business processes by transforming them into computerized workflows. Thanks to its flexible and extensible design, jBPM allows businesses to model their processes graphically using standard notations such as BPMN (Business Process Model and Notation).

Business Process Modeling with JBPM

JBPM offers several advantages for business process modeling. Here are some of the key benefits of JBPM:

1. Graphical Modeling: JBPM uses an intuitive graphical modeling language (BPMN) to represent business processes. This makes it easier to understand and communicate between non-technical stakeholders, such as project managers and business leaders.

2. Flexibility: JBPM allows for modeling complex business processes with flexible workflow rules. It provides the ability to define decisions, conditions, and deadlines to guide the workflow according to specific business requirements.

3. Process Automation: JBPM enables the automation of business processes, which helps reduce manual tasks and human errors. It can orchestrate and manage the execution of tasks, steps, and activities within a business process, offering better efficiency and increased productivity.

4. Tracking and Monitoring: JBPM provides built-in features for tracking and monitoring business processes. It allows real-time visualization of process progress, detects bottlenecks, and takes corrective actions to improve performance and efficiency.

5. Easy Integration: JBPM can be integrated with other systems and applications, ensuring seamless collaboration between various components of the business's IT ecosystem. It supports web services, APIs, and connectors to facilitate integration with existing systems.

6. Exception Management: JBPM offers advanced exception handling mechanisms. It enables the efficient management of errors, exceptions, and unexpected scenarios through compensation, recovery, and redirection mechanisms to ensure smooth execution of business processes.

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7. Scalability and Extensibility: JBPM is designed to be highly scalable and extensible. It can support a wide range of use cases, from simple processes to complex business processes, and adapt to the evolving needs of the business.

Process Analysis

Process Description

The F2 process concerns the full support of the student in the context of their orientation, while facilitating their integration into the university environment.

- Process Name: STUDENT SUPPORT IN THEIR TRAINING

- Process Type: Operational

- Model Type: Functional

Process Context

The implementation of support mechanisms can be based on the idea of a deficiency within the university that needs to be compensated. It involves introducing a new role within the university environment to enhance its pedagogical and social functioning, and to provide personalized support to students. These students need to construct the meaning of their presence at the university around a project that is either already developed, in progress, uncertain, or non-existent.

Challenges

Supporting students is a priority and a key challenge for the state:

- Studying in good conditions

- Successfully completing studies

- Preparing for their professional future

Process Objective

The objective of student support is primarily the automation of the student's responsibilities, leading them to take ownership of their tasks. The main goals to be achieved with this process are:

- The full support of the student in their orientation while facilitating their integration into the university environment.

- Guiding the student through their learning process.

- Providing a reference framework and action plan.

- Supporting, guiding, and directing the student as needed.

- Offering psychological and social support to the student.

- Facilitating the internal and external mobility of the student.

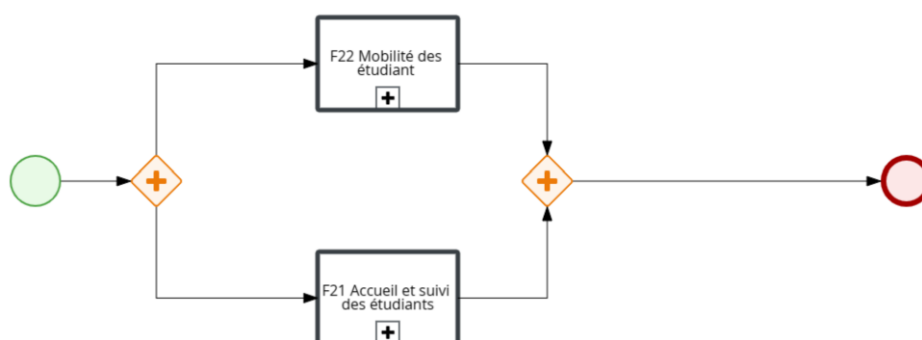### Process Definition

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Figure 1: Overview of the BP Definition

This diagram provides a high-level definition of the business process, outlining its main components and flow structure within the student support framework.

This process consists of two sub-processes:

1. Sub-Process F21: Student Reception and Support. The institution has a policy for welcoming, monitoring, and supporting student success: The goal is for the institution to ensure the best conditions for student success."
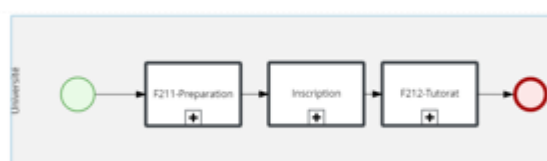

Figure 2: Student Process Modeled in jBPM

This diagram illustrates the complete student process as implemented using the jBPM framework. It captures the sequential flow of tasks from student onboarding to support services, ensuring clarity, traceability, and automation across various academic support stages.

1. Sub-Process F22: Student Mobility. The institution offers the possibility of internal (pathways) and external (national, international) mobility: The institution works to deploy and establish best practices to promote mobility with its partners."
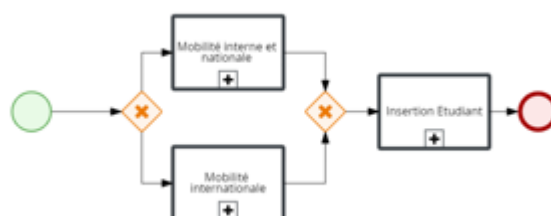

Figure 3: Sub-Process F22: Student Mobility Model

Process F211: New Bachelor's Registration: This process begins with the student choosing the program they wish to enroll in by filling out a form and submitting their application.
The application is then processed by the system, which submits the student's choices to the university. The university, in turn, will assign the student based on their choices and availability.
In the meantime, the student must complete their academic registration. Once the registration is completed, the

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university will validate the student's registration, assign a tutor, provide a student card, and set up an e-learning account."
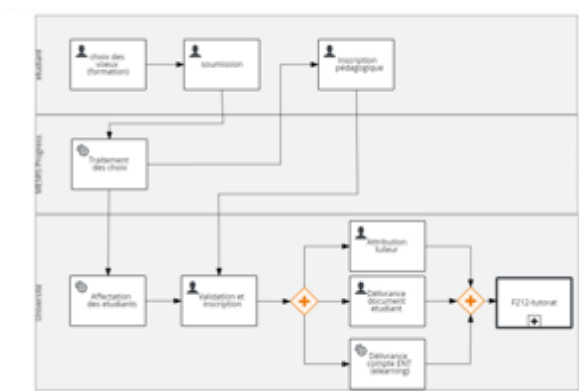

Figure 4: Workflow Execution Panel in jBPM

Data objects in jBPM are used to exchange information between the different steps of the process, store values necessary for the execution of the workflow, and make decisions based on this data. They play a crucial role in the modeling and automation of business processes using jBPM. Here is an example of a data object 'Request'."

Figure 5: Process Variables Configuration Example: DataObjects

This figure displays how process variables are configured in jBPM. Variables serve as dynamic data carriers throughout the workflow, enabling logic execution, condition validation, and real-time process adaptation.

Process Variables: In JBPM, process variables are used to store and manipulate data within the context of a business process. Process variables represent information specific to the process currently being executed and can be used to make decisions, perform calculations, track the process state, etc. Process variables can be defined at different levels, such as the process itself, individual tasks, or events. They can be of various data types, such as strings, numbers, dates, complex objects, etc. Process variables can be created, read, and updated throughout the execution of the process. They can be used to share information between different steps of the process and enable decision-making based on this data." In jBPM, input and output assignments are used to specify the data required for a task before its execution (input assignment) and to define the data produced after the task (output assignmenese assignments allow data exchange between the tasks of a business process. They can include constant

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values, process variables, or expressions evaluated during execution. Input and output assignments facilitate communication and data exchange between the steps of the process, thereby contributing to better automation and workflow management."
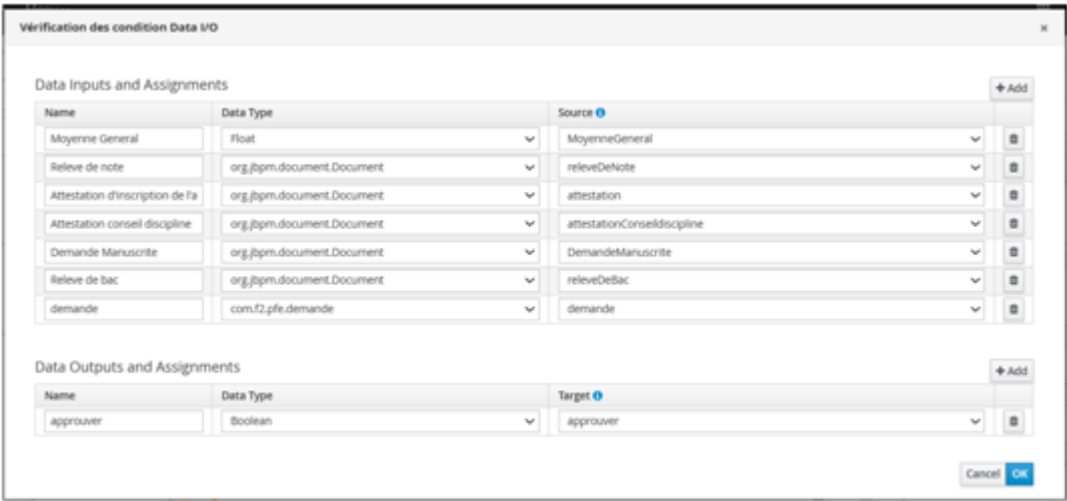

Figure 6: Deployment Interface in jBPM

The interface shown represents the deployment environment of jBPM. It demonstrates the execution stage where defined processes are compiled, deployed, and initiated, serving as the operational layer for process automation within the system.

Process Reports: In Business Central jBPM, you can generate reports on business processes to obtain detailed information about their performance and execution. Reports allow you to visualize key data, monitor performance indicators, and identify issues or opportunities for improvement."
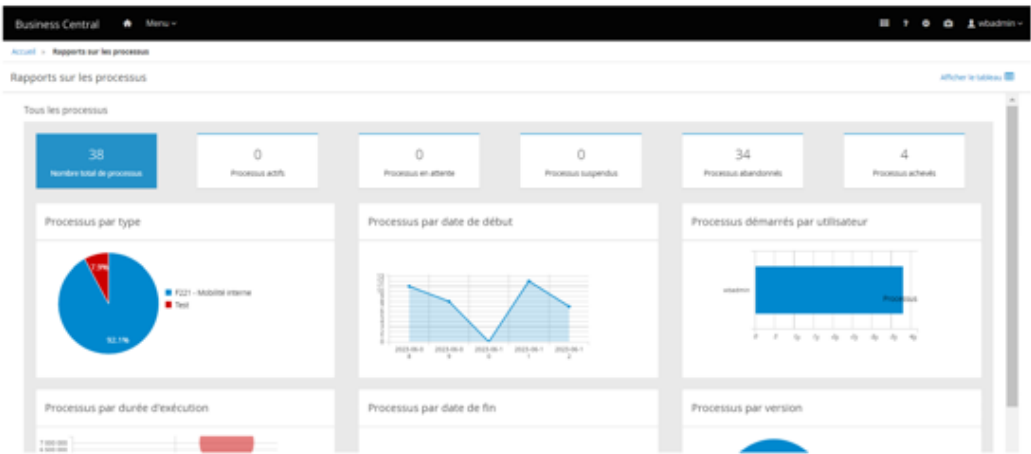

Figure 7: Process Deployment Steps in Business Central

This line chart visualizes the temporal trend of request submissions. By highlighting fluctuations in volume over specific periods, it helps stakeholders identify patterns, peak activity intervals, and process demand dynamics.

PostgreSQL
In our project, this study employed PostgreSQL in conjunction with jBPM (Java Business Process Management) to

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manage and store data related to our business processes. PostgreSQL is a powerful open-source relational database management system that offers numerous advanced features. Among its characteristics are :

- Reliability and stability

- Object-oriented architecture

- Extensibility

- Support for ACID transactions (Atomicity, Consistency, Isolation, Durability) to ensure data integrity and consistency

- Advanced query language

- Performance optimization

- Support for replication and high availability

By using PostgreSQL with jBPM, the team was able to integrate data management with business process automation. This provided us with a complete and consistent view of our data and ensured smooth and efficient execution of our processes.

Nom character varying (55)	Prenom character varying (55)	Age integer	Email character varying (55)	Wilaya character varying	Moyenne_generale real	aprouver character varying
Zidane	Sara	22	sara.zidane@email.com	Oran	11.2	Non
Bouazza	Karim	21	karim.bouazza@gmail.com	Oran	10.9	Non
Chaoui	Amina	23	amina.chaoui@gmail.com	Oran	11.2	Non
Belkacemi	Ahmed	20	ahmed.belkacemi@email.com	Oran	10.4	Non
Rahmani	Nassima	23	nassima.rahmani@gmail.com	Oran	10.1	Non
Chergui	Amir	23	amir.chergui@gmail.com	Bejaia	11.3	Non
Hamza	Djamila	21	djamila.hamza@gmail.com	Setif	11.1	Non
Ziani	Malik	23	malik.ziani@email.com	Tizi Ouzou	11.2	Non
Meziani	Sofiane	23	sofiane.meziani@gmail.com	Constantine	11.4	Non
Slimani	Ines	22	ines.slimani@gmail.com	Biskra	11.4	Non
Saidi	Farah	21	farah.saidi@gmail.com	Tizi Ouzou	11.4	Non
Benamar	Sara	21	sara.benamar@email.com	Tizi Ouzou	11.4	Non
Benyahia	Ismail	21	ismail.benyahia@gmail.com	Oran	11.4	Non

Figure 8: PostgreSQL Database

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Figure 9: PostgreSQL Database Configuration for jBPM

Qlik Sense is a business intelligence (BI) and data visualization software developed by QlikTech, a software company based in Sweden.In our paper, this study selected Qlik Sense as Qlik Sense as a tool for introducing KPIs. Qlik Sense is a visual and intuitive data analysis platform that offers powerful features for exploring, visualizing, and analyzing data more effectively.

jBPM Environment Configuration: jBPM requires extensive configuration, which is why the research followed the tutorial from the official website. This tutorial guided us through the necessary configuration steps to set up jBPM in our project environment. the researchers carefully followed the provided instructions, which allowed us to configure jBPM according to our specific needs. The official documentation was a valuable resource, providing detailed explanations and practical examples for each configuration step. As a result

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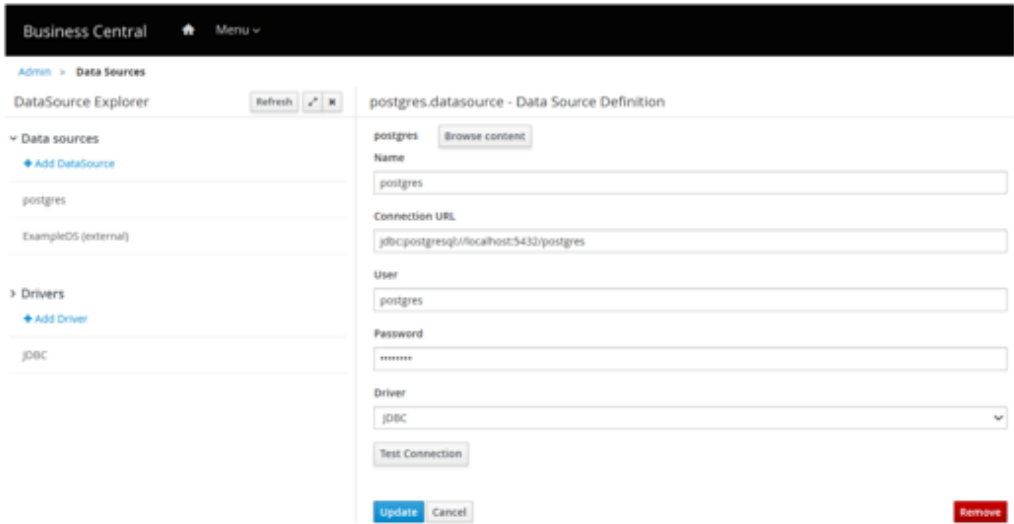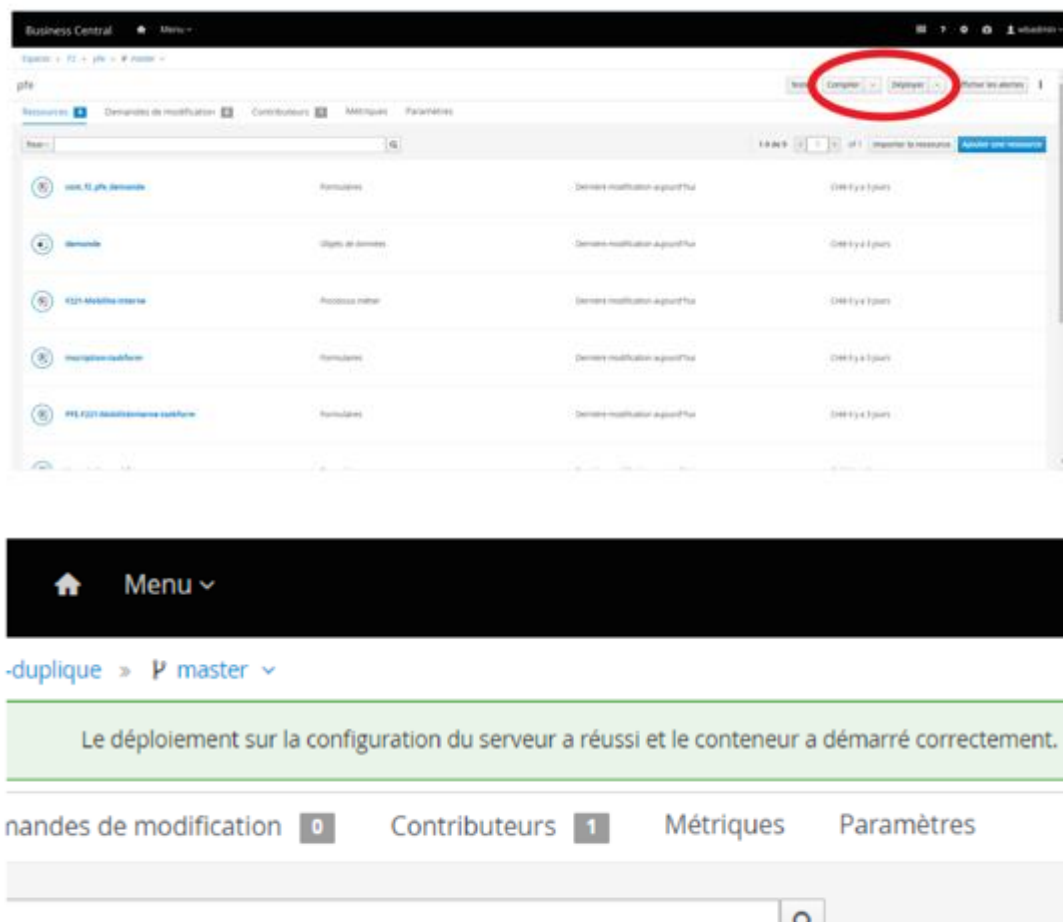**Figure 8:** Connecting to Our PostgreSQL Database

Figure 8: Deployment of the Internal Mobility Process

Deployment and Launch of the New Instance: To deploy the process, you need to click on Compile, then Deploy, as many times as needed by the project administrator.

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This figure illustrates the deployment steps of the internal mobility process within the jBPM engine, showing the transition from model validation to execution.

"Then, you need to start a new instance of the process. To do this, click on the New Process Instance button. A new instance will then be created to manage the task submission process."

Figure 10: Deployment of the Process on the jBPM Engine

The student logs in with their username and password.
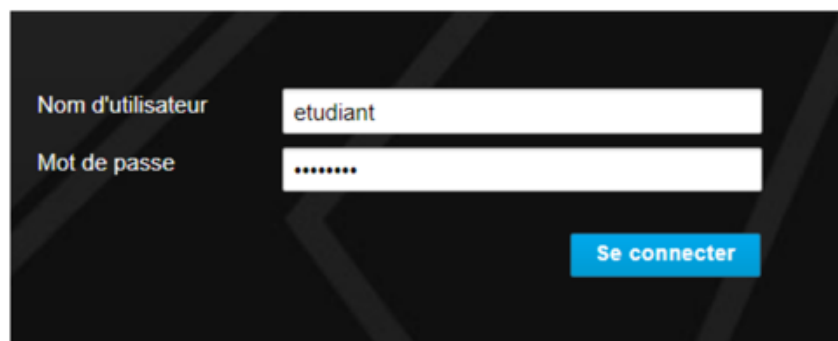
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Figure 11: Student Login Interface in Internal Mobility Process

Key Performance Indicators (KPIs): are at the core of our approach, as they are essential for monitoring and evaluating our internal mobility process. Using Qlik Sense, the research designed a dashboard that consolidates all the necessary KPIs and diagrams to track the progress of our process. This allows the Vice Dean of Education to stay informed, monitor, and oversee the state of mobility within the department. The dashboard provides access to numerous essential KPIs, such as the number of mobility requests submitted each year, the number of approved students based on their grades, and more. These key indicators offer a clear view of the situation and enable the Vice Dean to make informed decisions to improve the internal mobility process.
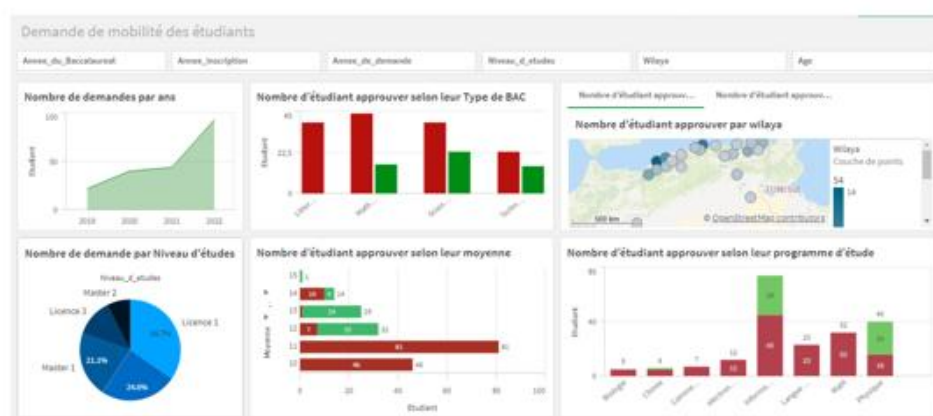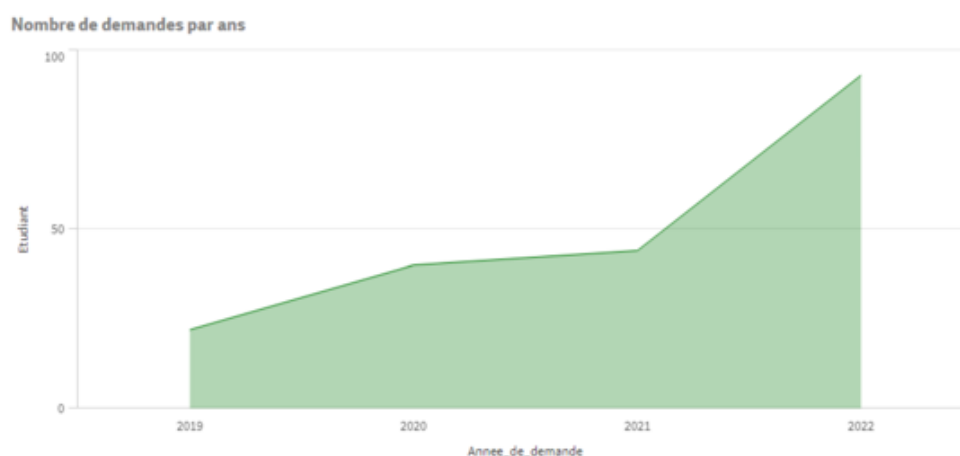

Figure 12: Visualization of KPIs

Figure 13: Number of Requests Over Time (Line Chart)

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This line chart visualizes the temporal trend of request submissions. By highlighting fluctuations in volume over specific periods, it helps stakeholders identify patterns, peak activity intervals, and process demand dynamics.
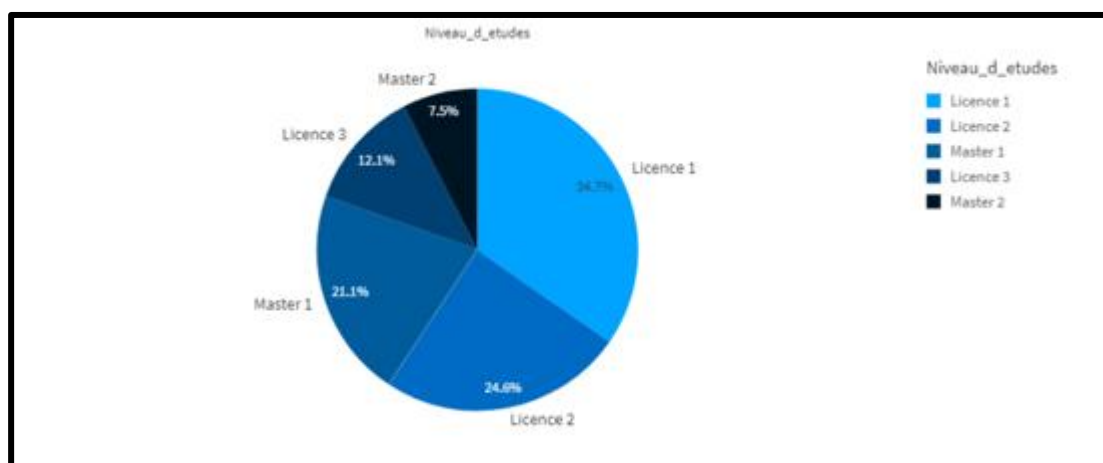

Figure 14: Pie Chart of Requests by Study Level

This pie chart provides a proportional view of request distribution across different academic levels. It offers clear insights into which programs or degrees are most in demand, aiding in planning and resource allocation.

Figure 15: Map of Approved Students by Wilaya

This geographic visualization presents the distribution of approved students by wilaya. Regions with higher student approvals are marked by darker shades, allowing for an intuitive understanding of regional trends. Such spatial analysis is instrumental for institutional planning and outreach strategies.

This paper comprehensively covered the deployment of the Internal Mobility process on the jBPM engine. the study addressed the configuration of the jBPM environment, overcoming challenges related to its integration with PostgreSQL and Qlik Sense.

the team successfully deployed the Internal Mobility process and conducted tests within the jBPM environment. The different stages of the process were detailed, including the deployment and initiation of a new instance, the student's task reception, form completion, and the vice-dean's verification process.

The vice-dean's responsibility in drafting the equivalence report upon acceptance was highlighted, as well as the student's enrollment procedure following the issuance of the equivalence report. Additionally, the notification process via email in case of rejection was discussed.

This paper highlighted the significance of digitizing business processes within organizations, focusing specifically on the process of supporting students throughout their education. the research explored the general concepts of business processes, emphasizing the role of digitization in enhancing efficiency and performance. Additionally, the research examined the various facets of business process digitization and the advantages it provides to organizations.

The implementation of a digitized business process for student support using the jBPM framework was presented as a concrete solution. A detailed analysis of the design and implementation phases was provided, with emphasis on technical considerations and the results achieved. This implementation demonstrated the feasibility and tangible benefits of digitizing business processes in the specific context of student support.

Business process digitization offers tremendous potential for organizations. It enables greater automation, reduced errors, workflow optimization, and improved collaboration among stakeholders. By digitizing the student support process, organizations can provide a more seamless and personalized experience, thereby enhancing student satisfaction and success.

In conclusion, digitizing business processes for student support presents numerous benefits and opportunities for organizations. This paper underscored the importance of this digital transformation and proposed a concrete solution using the jBPM framework. However, continued research and innovative efforts are essential to fully harness the potential of business process digitization. By adopting a proactive approach, organizations can enhance operational efficiency, optimize stakeholder experiences, and remain competitive in an ever evolving environment.

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