IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 27, Issue 3, Ser. 2 (May. – June. 2025), PP 01-12
www.iosrjournals.org

Use Of The UP Approach For The Digitization Of Student Evaluation Management And Academic Performance Analysis By Business Intelligence In Rural DRC

Kabango Dyuba Désiré[1], Bertin Mazunze[2], Lukusa Muvuala Vicky[3], Tubongye Shabani Arlène[4] And Ngoy Katongela Narcisse[5]
(Department Of Computer Science, Higher Pedagogical Institute (ISP) Of MITWABA, DR Congo)
(Department Of Computer Science, Higher Institute Of Commerce (ISC) Of Lubumbashi, DR Congo)
(Department Of Computer Science, Higher Institute Of Commerce (ISC) Of Lubumbashi, DR Congo)
(Department Of Computer Science, Higher Institute Of Commerce (ISC) Of Lubumbashi, DR Congo)
(Department Of Computer Science, Higher Institute Of Social Studies (ISES) Of Lubumbashi, DR Congo)

Abstract
In the Democratic Republic of Congo (DRC), and more particularly in rural areas, the student evaluation process remains largely manual, inefficient and untraceable. This situation compromises the reliability of pedagogical decisions and hinders the continuous improvement of the quality of teaching. This article proposes an innovative digital solution for the management of assessments and the analysis of academic performance, developed using the UP (Unified Process) method and Business Intelligence (BI) tools. The architecture is based on a Flutter/Dart application, a real-time database via Firebase, and dynamic dashboards generated with Google Data Studio. The aim is to ensure an automated, transparent and contextualised assessment, adapted to the socio-economic realities of rural areas. The experimental results confirm a significant improvement in the time it takes to publish results, the accuracy of the data and the access to relevant decision-making analyses for educational managers.
Key Word: *UP method, business intelligence, academic evaluation, digitalization, rural environment, UML, Firebase, Flutter, Google Data Studio, RDC*

Date of Submission: 27-04-2025 Date of Acceptance: 07-05-2025

I. Introduction

The digital transformation is redefining the standards of education around the world, particularly in terms of transparency, efficiency and pedagogical monitoring. However, rural areas in the DRC still face many structural limitations: lack of technological infrastructure, poor connectivity, and reliance on manual evaluation methods. These challenges affect the reliability of the assessment process, increase the risk of errors, and limit data-driven instructional decision-making. In order to avoid subjectivity in distance assessment, it is necessary to determine the learning objectives and the assessment methodology, "Knowing how to teach is knowing how to evaluate". Assessment is a crucial element in the learning process (Benali et al., 2023). As a result, computerization, analysis and real-time monitoring of results have become essential to identify opportunities and minimize risks, in the face of an incredible technological growth that is multiplying the sources of information and exploding the volume of data. Hence the role of business intelligence (Tisluck, 2014).

In this context, the implementation of a digital solution based on the UP approach, combined with Business Intelligence technologies, represents a strategic step forward. The approach aims to transform a traditionally cumbersome and inefficient process into an intelligent, automated and accessible platform that can provide stakeholders with real-time analytics to optimize education governance.

II. Material And Methods

Materials

This study, aimed at proposing a concrete solution for the digitization of student assessments, required the use of various hardware and software tools.

Materials (Physical Resources)

Regarding hardware resources, our study initially required equipment such as personal computers (PCs), smartphones, and a stable internet connection to access the online assessment system. These tools were essential for collecting and accessing the data needed for the development of the system.

Materials (Software Resources)

For the system modeling, we used the ArchiTech tool, which supports system modeling through the UML (Unified Modeling Language). This software was essential for the structured design of the system, making it easier to visualize interactions and data structures.

The solution was developed using the Flutter/Dart programming language, chosen for its ability to create cross-platform mobile applications (Android and iOS). We used Android Studio as the integrated development environment (IDE), where all the necessary plugins were installed to ensure smooth and efficient development. For data management, we opted for Firebase, a mobile development platform that enables real-time data handling. Firebase was used for data persistence, the implementation of a secure authentication system, and synchronization of data between users and the cloud.

Methods

The Methodology is the backbone of any research work, especially when conducting a scientific study. It outlines the operational framework established, the resources (human or otherwise) involved in the study, as well as the data collection instruments (N'da, 2024). In our case, we used the following:

Data Collection Methodology: The Case Study Approach

The Democratic Republic of Congo (DRC) encompasses a wide diversity of rural areas, which makes it difficult to study all of them simultaneously. Therefore, within the framework of this research, we adopted a case study approach, selecting ISTM M'SIRI due to the accessibility of data and the favorable conditions for information gathering. The case study not only enabled an in-depth analysis of the specific context of this institution but also served as a methodological tool for collecting relevant data.

The case study was chosen as the primary method for data collection. By focusing on ISTM M'SIRI, we were able to directly observe the specific needs and challenges faced by users in a rural environment. This choice facilitated the collection of precise and context-sensitive data, which was essential for analyzing the existing processes and formulating appropriate recommendations. Data collection was carried out using multiple instruments and techniques:

- **Direct Observation:** A field study was carried out to identify the limitations of the current system at ISTM M'SIRI 1er in Bunkeya. This observational approach allowed for the collection of empirical data on current practices and the specific challenges encountered by users.
- **Interviews:** Semi-structured interviews were conducted with instructors, administrative staff, and students in order to gather their functional requirements and experiential feedback regarding the existing system.
- **Questionnaires:** Structured questionnaires were administered to users to evaluate their level of satisfaction and to capture their expectations concerning the proposed solution.

Modeling and Development Methodology: The Unified Process (UP) Method

The methodology adopted is the UP (Unified Process) method, which is based on an iterative and incremental approach, precisely allowing the system to be tested, evaluated, and continuously adjusted at each development stage. The UP (Unified Process) method is a software development framework that relies on proven software engineering practices. It provides a disciplined approach to assigning tasks and responsibilities within a development organization. Its goal is to ensure the production of high-quality software that meets the needs of end users within a predictable schedule and budget (Wautelet et al., 2003). Below are the different phases of the UP method applied to this project:

- **Inception:** This initial phase allowed us to understand the users' needs and analyze the results of the case study. Based on field observations and interviews with the actors at ISTM M'SIRI, this step helped define the functional and technical requirements, with a focus on the specific constraints and needs of the local context.
- **Elaboration:** During this phase, the collected requirements were formalized and structured using UML models. These models include use case diagrams, class diagrams, and sequence diagrams, ensuring a shared understanding of the system to be built. These diagrams served as the foundation for the solution design, visualizing the interactions between different actors and the data structure.
- **Construction:** This phase marked the beginning of the actual development of the solution. The Flutter/Dart environment was used to create the user interface, ensuring portability across Android and iOS platforms. Concurrently, Firebase was integrated to ensure real-time data persistence. This step translated the specifications from the elaboration phase into a functional system.
- **Transition:** Finally, the transition phase involved testing the system in a real environment with end users. Functional testing was carried out to validate the correct operation of the system, followed by user training. This phase allowed us to gather feedback to adjust the solution and ensure its optimal adoption.

This method will be applied and practiced using its UML modeling language. UML, which stands for Unified Modeling Language, was born from the merger of dominant object methods (OMT, Booch, and OOSE), then standardized by the OMG in 1997. UML quickly became an essential standard. UML is not the origin of object concepts, but it provides a more formal definition and brings the methodological dimension that was missing in the object approach (Piechocki, 2007).

Solution Analysis and Design

To make the use of the UP (Unified Process) method a reality, it was necessary to use a modeling language to facilitate the structured and visual representation of the system. This approach helps to clarify the interactions between the different components of the system and to ensure a shared understanding between stakeholders.

Business Analysis

Business analysis was the first key step in designing the solution. It allowed us to understand the existing processes within the ISTM M'SIRI, in particular those relating to the management of student evaluations. This analysis involved the collection of functional needs through interviews with the various stakeholders of the institution, including teachers, administrators and students.

Identification of the actors:

The notion of actor can be interpreted in different ways depending on the field, but in its general sense, an actor refers to any person or entity with a role to play in a system. More specifically, in the context of information systems, an actor represents a role played by an external entity (human user, hardware device or other system) that interacts directly with the system under study(Roques, 2021).
Referring to our current student evaluation system, we have identified the following actors:

Table No.1: Table of business players

No.	Actor	Description
1	Student	The student is the main actor concerned by the evaluations. He consults his ratings and receives feedback on his academic performance.
2	Teacher	The teacher is responsible for the evaluations, he manages the allocation of the grades.
3	Apparitor	The apparitor is responsible for logistical and organizational support, including the transmission of results and coordination between teachers and students.

Identification of use cases

The notion of use cases seems to be understood in several ways, but in the IT context, a use case is defined as "a description of a set of interaction scenarios between a system and one or more actors, aimed at achieving a specific outcome for the latter"(Booch et al., 2000).

In the context of the current student assessment system, a business use case is a real-world feature of the current system that makes it easier to manage assessments, from entering grades to viewing them by students. These use cases translate the services offered to the various players, whether it is a fully manual or partially automated process.
The table below shows the use cases identified in the current system:

Table No.2: Business Use Case Table

No.	Business Use Case	Stakeholder	Description
1	To Schedule Courses	Apparitor	This use case enables the apparitor to schedule courses to be delivered.
2	To Deliver Courses	Teacher	This use case allows the teacher to deliver the scheduled course content.
3	To Schedule Assessments	Apparitor	The apparitor schedules assessments by defining dates, times, and organizational details.
4	To Create Assessments	Teacher	The teacher designs the assessment by preparing questions, tasks, and marking criteria.
5	To Grade Assessments	Teacher	The teacher evaluates and grades students' assessments based on predefined criteria.
6	To Submit Assessments	Student	The student completes and submits the assessment through the system.
7	To Record Grades	Teacher	The teacher records students' grades into the system and notifies students of the results.
8	To View Results	Student	This use case allows the student to access and view their assessment results.

Business context diagram

The context diagram is an essential tool for representing the interactions between the system we design and the external entities that surround it. This type of diagram makes it possible to visualize the relationships between the system under study and external actors or devices, showing the flows of information and key exchanges(Paludetto et al., 2004). In this study, the context diagram describes the interactions between the main actors in the student assessment system, namely students, teachers and apparitors.

The following image illustrates these interactions and the associated information flows in the business context of our student evaluation system.

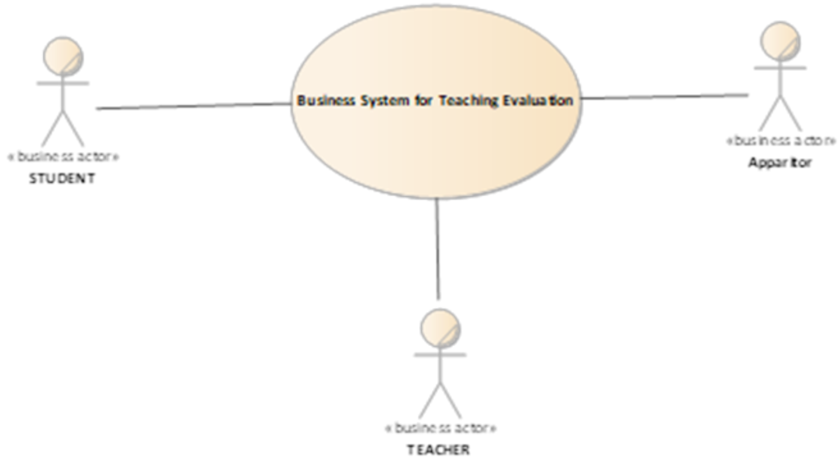

Figure No. 1: Business context diagram

Business Use Case Diagram

In general, a use case diagram lists the usage functions that the system offers to each of its user actors in order to satisfy their needs. It must not specify how it provides these services(Lamy, 2012). This diagram groups the use cases, and the use cases describe the interactions between the actors and the system, highlighting the functionalities that the system must offer to satisfy the needs of the users (Mazunze, 2025). By clearly identifying the roles of the actors involved and the services that the system offers them, this diagram helps to understand how business processes are organized and executed and there, to help us understand who does what? in this system.

The business use case diagram includes features such as course management, scheduling assessments, composing quizzes, participating in assessments, and recording ratings. This diagram highlights how each actor – apparitor, teacher and student – interacts with the system to achieve the objectives related to the evaluation process.

The following image shows the student assessment system business use case diagram, detailing the roles of each actor and the associated interactions. This diagram provides a solid basis for designing and modeling the system's functionality.

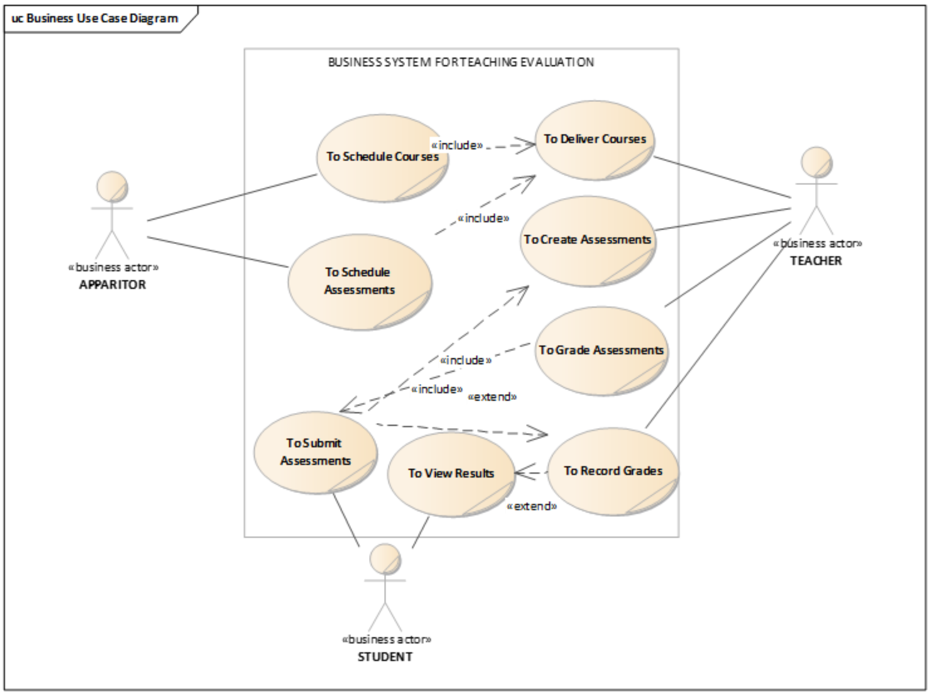

Figure No.1: Business Use Case Diagram

Business Activity Diagrams

The business activity diagram is a key tool for modeling business processes as activity flows. According to(Booch et al., 2000) , this diagram is used to represent the steps of a business process and the associated decisions, while illustrating the interactions between the various actors and the system. This type of diagram is particularly useful for visualizing sequences of actions and identifying opportunities for improvement or automation.

As part of the student evaluation system, the business activity diagram describes the main steps in the evaluation process, from the management of courses to the fact that students view the results. The image below shows our business activity diagram.

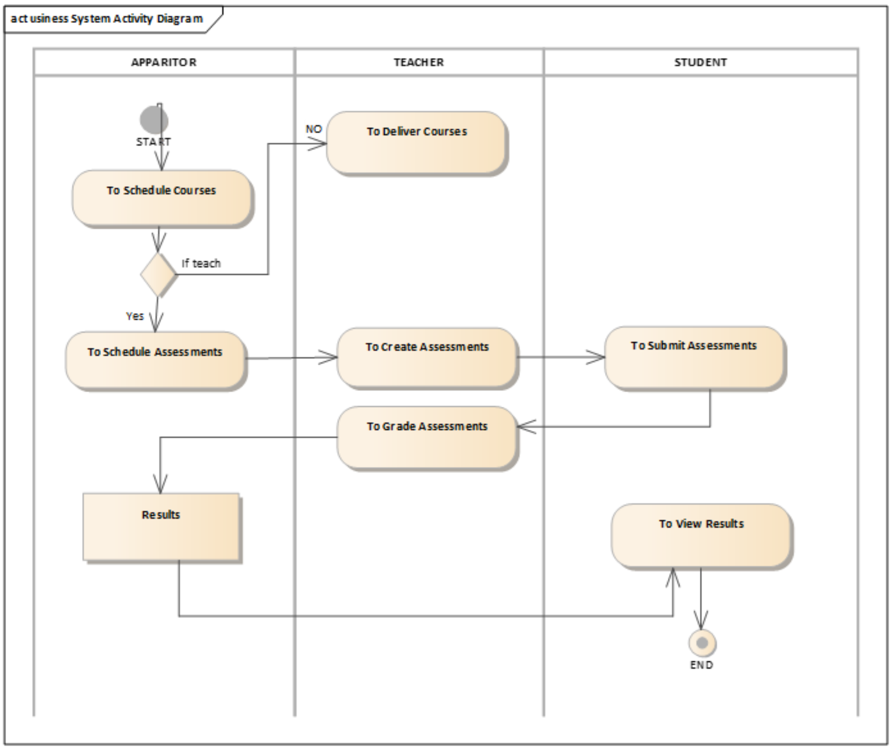

Figure 2: Business Activity Diagram

Critical analysis of the existing situation

The current system of academic evaluation, as practiced in several higher education institutions in the Democratic Republic of Congo (DRC), presents a set of practices that, although rooted in institutional practices, reveal important limitations in terms of efficiency, transparency and equity. An in-depth analysis of this system highlights the structural challenges hindering its optimization.

Despite its weaknesses, the current evaluation system has some strengths that should be highlighted. First, teachers, apparitors, and students have a good grasp of traditional processes, which is an advantage in terms of educational continuity. In addition, the organizational structure is well established, with a clear division of responsibilities, thus facilitating coordination among the actors. Institutions also have flexibility to adapt evaluation methods and schedules to their specific context. Finally, the existence of a rudimentary manual system suggests a possibility of gradual evolution towards more modern digital approaches.

However, several structural shortcomings significantly hamper the effectiveness of the system. The first weakness is the lack of automation: operations such as entering grades, preparing evaluations or generating report cards are carried out manually, with an increased risk of human error and a significant workload. In addition, the lack of traceability makes it difficult to monitor actions and facilitates the emergence of unethical practices such as corruption, favoritism or tribalism. In addition, there is a recurring delay in the publication of results, generating harmful uncertainty for students. The system also does not provide easy access to synthetic and analytical performance data, limiting the ability of teachers and administrators to make informed decisions. Finally, students rarely receive constructive feedback on their evaluations, reducing their margin for academic progress.

III. Results

Following the critical analysis of the current student evaluation system, and after identifying its strengths and weaknesses, we proposed the implementation of a digital system based on the principles of Business

Intelligence (BI) as a solution. The main objective of this study was to design an integrated platform that would not only automate assessments, but also analyse academic data in depth to better assess student performance.

To achieve this goal, we have adopted the modeling approach through the Unified Process (UP) method, combined with the UML (Unified Modeling Language) modeling language. This methodological choice allowed us to structure the development process in an iterative way, while ensuring better communication between the project's stakeholders. The integration of BI tools at the heart of the system was considered to guarantee an advanced data analysis capacity, and thus support pedagogical and administrative decisions on reliable indicators.

Design of the teaching evaluation system

The information system design process has been assimilated to a rigorous modelling process, in accordance with the work of Rolland and Flory (1990), who emphasize the importance of data modelling as the heart of the development of an effective information system. This approach makes it possible to clearly visualize the interactions between the different entities of the system, to define the flows of information, and to ensure both functional and technical coherence.

With this in mind, several UML diagrams have been developed, including use case diagrams, class diagrams, activity diagrams, context diagrams, deployment diagrams and others. These representations made it possible to formalize the functional requirements of the system, to describe the typical use scenarios, and to define the roles and responsibilities of the different actors (teachers, apparitors, students, administrators). These modelling results are presented in the form of tables and diagrams in the following sections, illustrating the structure and projected operation of the system.

Functional and non-functional requirements

In the results phase, here, it was a question of identifying the functional requirements that describe the behavior of the system and define the functions or services that the system must perform (Mazunze, 2025) , as well as those that ensure that the system meets the expected levels of performance, safety, and reliability while avoiding the pitfalls of manual approaches (Baltus, 2001).

Table No.3: System Functional Requirements Table

No.	Demand	Description
1	Course Management	Allow apparitors to manage courses (add, modify, delete) and related information.
2	Scheduling of assessments	Allow apparitors to schedule assessments by defining dates, times, and modalities.
3	Composition of the assessments	Offer teachers the possibility of creating questionnaires with different types of questions (MCQs, open-ended answers).
4	Student Engagement	Provide students with secure access to assessments and the ability to submit their responses online.
5	Recording Odds	Allow teachers to enter assessment results for each student.
6	Viewing the results	Allow students to view their ratings and receive detailed feedback on their performance.
7	Reporting	Provide teachers and administrators with detailed reports on overall and individual academic performance.
8	Analytics Visualization	Propose performance indicators and visualizations to identify trends and gaps.

The table below shows the various non-functional requirements of our system and their role in this study:

Table No. 4 : Non-functional system requirements

No.	Demand	Description
1	Accessibility	The system must be accessible at any time, on various devices (computers, tablets, smartphones).
2	Interface intuitive	The user interface should be simple, user-friendly, and tailored to the skills of teachers, students, and apparitors.
3	Reliability	The system must ensure stable operation, minimizing outages and interruptions to ensure a smooth experience.
4	Data Security	User data, including ratings and results, must be protected by robust mechanisms.
5	Performance	The system must provide fast response times for critical operations such as submitting responses and viewing results.
6	Scalability	The architecture must allow the future addition of new functionalities or the adaptation to changes in educational needs.
7	Compliance with standards	The system must comply with local and international educational standards for online assessment and data protection.

Identification of the Actors of the New System

In the business system, we have said that an actor is any person who has a role to play in the current system of teaching evaluations. However, in the smart system, it is anyone with a role to play in the new online teaching evaluation system, the identified actors interact at different levels of the process, each with a specific role to ensure the proper functioning of the system. We are still representing the players here, but this time those of the new system, because computerization in companies introduces new components while modifying or eliminating certain elements of the existing systems. Moreover, it is in this logic that (Henri, 2000) asserts that the irruption of Internet technologies is disrupting the organization and architecture of traditional corporate information systems.

Here is a table describing the actors of our evaluation management and academic performance analysis project:

Table No. 5 : Table of the actors of the new system

No.	Actor	Description
1	Student	The student participates in online assessments, submits their answers, consults their results, and receives feedback to improve.
2	Teacher	The teacher designs assessments, captures student ratings, and uses reports to analyze academic performance.
3	Apparitor	The apparitor schedules assessments, manages classes, and organizes schedules to ensure efficient planning.
4	Administrator	The administrator oversees the system, configures settings, maintains overall smooth operation, and ensures data security.
5	Decision-maker (Academic Secretary General)	The decision-maker accesses the system's dashboard to view overall performance indicators and make strategic decisions.

Identification of use cases

In business system modeling, we previously presented the use cases for the system's functionality when it was completely manual, without automation. In accordance with the Unified Process (UP) method, these business use cases are typically represented with a specific notation, often indicated by a barred head.

In this section, we discuss the use cases for our new computerized student evaluation system. The table below presents the use cases identified in our online teaching evaluation computer system, specifically designed for rural areas in the Democratic Republic of Congo.

Table 6: Use Case Identifications

No.	Use Case	Stakeholder	Description
1	To Authenticate	All Actors	Allow users to log in to the system through a secure interface based on their role.
2	To Schedule Courses	Apparitor	Allow the apparitor to create, edit, or delete courses and manage related information.
3	To Deliver Courses	Teacher	Allow the teacher to deliver the course content.
4	To Schedule Assessments	Apparitor	Schedule evaluations by defining dates, times, and organizational arrangements.
5	To Create Assessments	Teacher	Allow teachers to design assessments with various question types and scoring criteria.
6	To Submit Assessments	Student	Offer students the opportunity to complete questionnaires and submit their responses online.
7	To View Results	Student	Allow students to view their grades and receive detailed feedback on their performance.
8	To Analyze Performance	BI Engine (Google Data Studio)	Automatically analyze data and generate visual performance reports and insights from system records.
9	To View Metrics	Decision-maker (Academic Secretary General)	Allow the decision-maker to access the dashboard to view overall performance indicators and key statistics.
10	To Manage Users	Administrator	Allow the administrator to add, modify or delete users (teachers, students, apparitors, decision-makers).

Use Case Diagram

The following image shows the use case diagram of our online student academic performance evaluation and analysis management system.

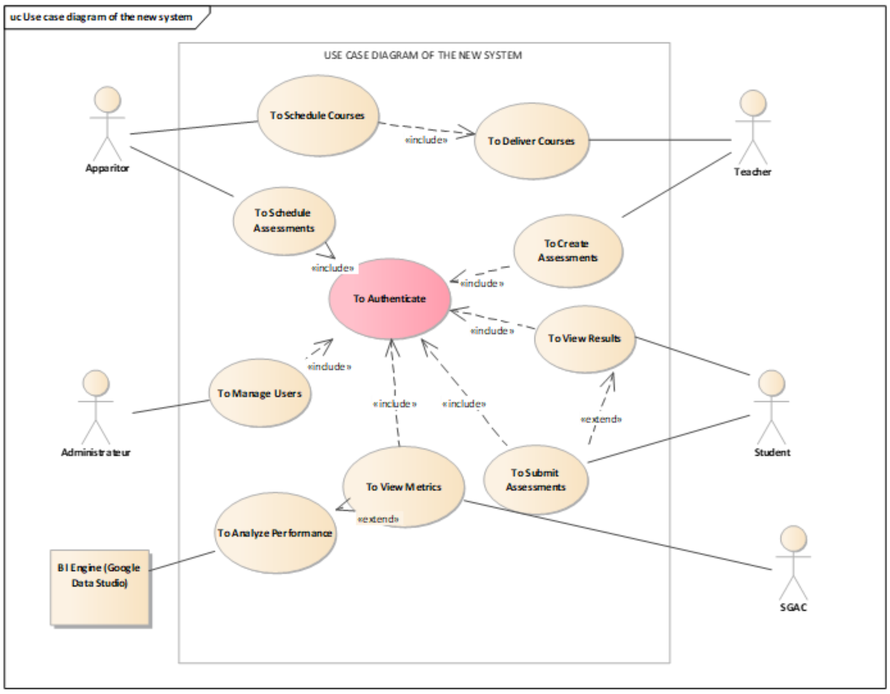

Figure 3: New System Use Case Diagram

Class Diagram

Class diagrams are fundamental to the object modeling process and model the static structure of a system. In UML, a class represents an object or set of objects that share a common structure and behavior. Classes, or instances of classes, are common model elements in UML diagrams(IBM, 2021). The purpose of the class diagram is to highlight the classes of a system with the relations that associate them, in particular, compositions and generalizations(Badir, n.d.). As part of our online teaching evaluation system, the class diagram describes the fundamental elements, such as entities, their attributes, methods and relationships. This diagram is specifically tailored to the features and actors identified in our system.

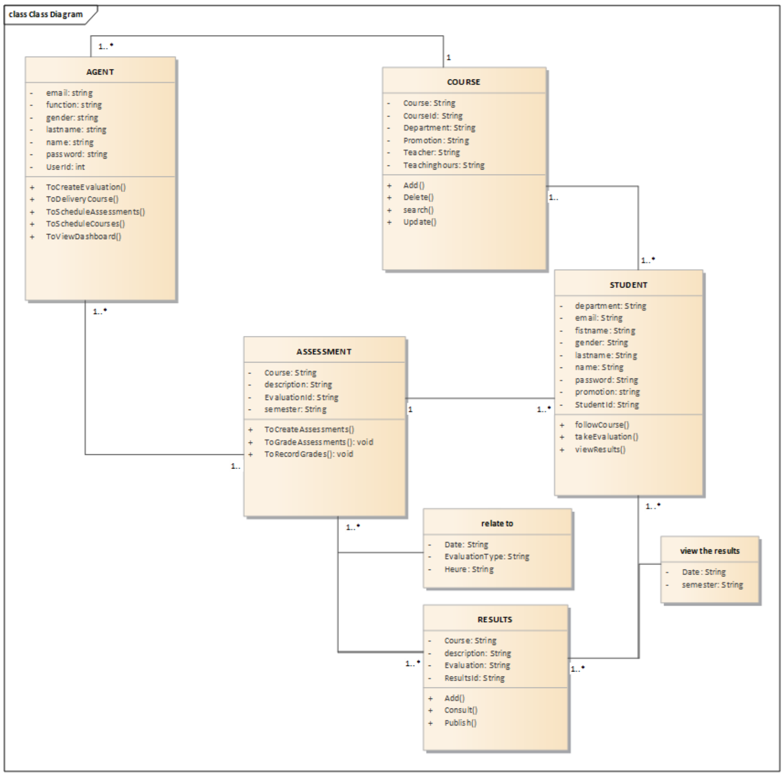

Figure 4 : Class diagram of the new system

Deployment Diagram

The deployment diagram is a UML representation used to illustrate the physical architecture of the system. It shows how software components are deployed on hardware resources (servers, databases, clients) and how these elements interact. In our online academic performance analysis evaluation system, the deployment diagram describes the distribution of features across hardware nodes, such as users, servers, databases, on the network. Deployment diagrams are used to represent nodes and their connections (Quatrani, 2000).

The following figure shows the rollout diagram for our online student assessment system.

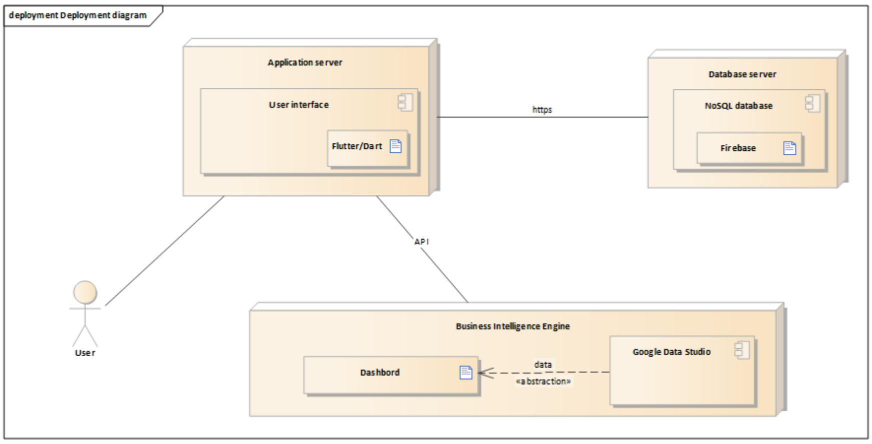

***Figure No. 5**: Deployment diagram*

Our deployment diagram above presents the integration of the Business Intelligence (BI) engine at the heart of the architecture of the system developed, in connection with the UP approach. In this study, the analysis of the data collected via the application, designed with Flutter, is carried out using a BI engine symbolized by Google Data. This engine transforms raw evaluations into key performance indicators (KPIs), which are visualized in an interactive dashboard for strategic analysis of academic performance. The mobile/web app, accessible to students, teachers, and administrators, is hosted on an application server that communicates with a NoSQL database, Firebase, optimized for rural areas with low connectivity. Communication between the various components of the system, including the user interface, database, and BI services, is provided by secure APIs, ensuring smooth integration and real-time synchronization of data. This distributed architecture also allows for easy scalability for deployment across multiple institutions, ensuring efficient assessment management and real-time analysis of student academic performance.

Transition state diagram

The Transitions State diagram describes the different states of an object (for example, an assessment or a user account) and the events that cause a transition from one state to another. That is, they describe the possible states of an object in the system and the events or actions that cause transitions between those states.

The following figure shows the transition status diagram of our online student evaluation and academic performance system.

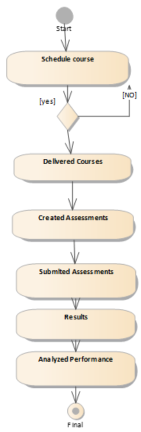

Figure No. 6: Transition state diagram

Architecture of the student evaluation system

The architecture of the system plays a fundamental role in the implementation of a reliable, efficient and scalable system. It determines how software and hardware components interact to meet functional and non-functional requirements. According to Krob, (2009), it is also important to understand that architectural thinking is in some ways opposed to classical analytical thinking. Reasoning as an architect is in fact absolutely not about trying to understand in the smallest detail how the system in question will work (which would be what an analytical engineering approach would focus on), but much more about identifying what the major structural invariants of the system will be in order to then let the system find its own balance within the architectural framework that it will have been given (and that it will have to structurally preserve and respect).

In the context of this study, which aims to implement a digital system for evaluating and analyzing the academic performance of students in rural areas in the Democratic Republic of Congo, a three-tier client-server architecture was adopted. This choice is based on the need to clearly dissociate responsibilities, to promote modularity, to allow for scalability, and to ensure efficient management of resources. The integration of a Business Intelligence engine (Google Data Studio) is a central element of this architecture, making it possible to transform data from evaluations into key indicators that can be visualized via interactive dashboards for decision-making purposes.

The architecture is structured around three main levels. The first level, known as the presentation level, concerns the user interfaces, developed using the Flutter/Dart framework, and accessible via web or mobile applications. These interfaces allow the various players in the system (students, teachers, administrators, decision-makers) to interact fluidly and consistently with the functionalities offered. The second level, the application logic layer, is hosted in the cloud and supports business rule management, including course planning, scheduling and remediating assessments, and preparing data for the BI engine. This tier uses the capabilities of Firebase Cloud Functions to ensure scalable and responsive execution of business processes. Finally, the third tier, dedicated to data management, is based on Firebase Firestore, a NoSQL database offering high performance, a flexible structure, and real-time synchronization. The data is then exported or synced to Google Data Studio, enabling visual and dynamic analysis of students' academic performance, contributing to better academic decision-making. The following image, shows the architecture of our system, as described earlier:

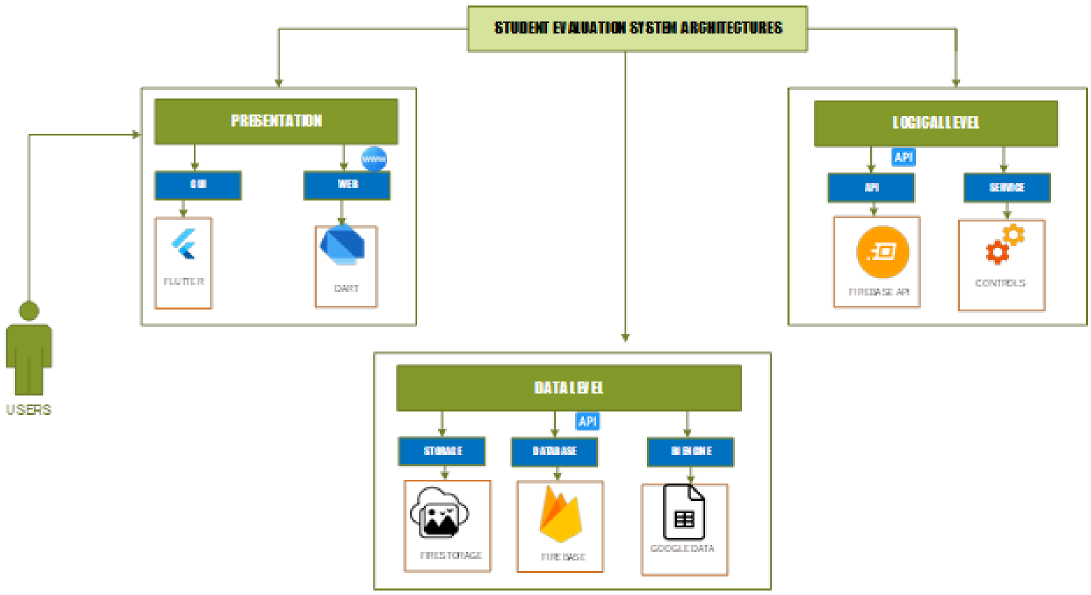

Figure No. 7: System architecture

IV. Discussion

The evaluation of the academic performance of online students in a rural context such as that of ISTM M'SIRI revealed concrete and relevant results regarding the impact of the proposed solution. By implementing Business Intelligence tools, this research not only made it possible to test the technical effectiveness of the solution, but also to collect rich feedback from teachers, administrators and learners.

The case study approach proved to be judicious insofar as it offered a real field of experimentation, anchored in a rural context typical of the Democratic Republic of Congo. The ISTM M'SIRI, thanks to the accessibility of the data and the commitment of local actors, made it possible to collect relevant information through direct observation, interviews and questionnaires. This approach has facilitated a better understanding of the specific needs of users in this type of environment.

The tests carried out have shown that the automation provided by Business Intelligence tools significantly reduces the time spent on the analysis of educational data. Performance evaluation processes that used to take several weeks could be completed in a matter of days, saving a significant amount of time for teachers and academic administrators.

In addition, the automatically generated analyses allowed a clearer and more objective reading of student performance. Teachers have found that instructional recommendations have become more accurate and focused than with traditional manual methods. This clarification has encouraged a more effective adaptation of teaching strategies to the realities on the ground and to the needs of learners.

Feedback from users has been very positive overall. From a practical point of view, the simplification of the assessments, the speed of access to the reports, as well as the relevance of the analyses provided, were the most appreciated elements. The proposed dashboards and visualizations strengthened the capacity of teachers and administrators to make evidence-based decisions, contributing to a significant improvement in the quality of online teaching in a resource-limited setting.

However, some challenges were overcome, especially with regard to the solution's dependence on data quality. Erroneous or incomplete information can affect the reliability of the analyses generated. In addition, the optimal use of Business Intelligence tools requires adequate user training. The experience at ISTM M'SIRI has shown that without technical support, some users may encounter difficulties or make partial use of the available features.

In summary, the results obtained through this case study confirm that the digitization of evaluation management and the integration of Business Intelligence in rural areas can effectively meet current pedagogical needs. Nevertheless, to sustain these advances, it is essential to invest in the quality of data and in the development of the skills of educational actors through targeted training and continuous technical support.

V. Conclusion

This research explored the use of the UP (Unified Process) approach and Business Intelligence tools for the digitization of student assessment management and analysis of academic performance in rural areas in the Democratic Republic of Congo, focusing on the ISTM M'SIRI as a case study. The results obtained demonstrated the significant impact of the automation of educational processes on reducing analysis time, improving the accuracy of pedagogical recommendations and adapting teaching strategies more effectively. The study showed that process optimization, speed of access to reports, and personalization of recommendations were essential contributions for teachers, administrators and learners.

However, significant challenges remain, particularly due to the constraints inherent in rural areas. The constant lack of internet access, power interruptions and inadequate energy infrastructure remain major obstacles to the implementation and sustainability of effective digital solutions. In addition, data quality and user training are crucial issues to ensure the successful adoption of these tools. Thus, although the results have been promising in the ISTM M'SIRI, it is obvious that the integration of digital tools into the education system in rural areas requires a specific consideration of these challenges.

In conclusion, the case study at ISTM M'SIRI showed that the digitization of evaluations and the analysis of academic performance using Business Intelligence tools represent a promising solution to improve the management of education in rural areas. Nevertheless, measures will have to be taken to overcome the problems of access to technology and energy. For example, solutions based on infrastructure that are less dependent on constant connectivity or partnerships with local companies to provide alternative energy sources could be considered.

Regarding future prospects, the extension of the system to other schools in rural areas could make it possible to test and adapt the solution in different contexts, thus contributing to a better generalization of the tool on a national scale. A hybrid approach, combining local and mobile solutions, could address connectivity and energy challenges. In addition, the smoother integration of data from various sources could provide more comprehensive and predictive analytics. In addition, the integration of advanced artificial intelligence modules would make it possible to offer more personalized and dynamic recommendations, based on the specific needs of learners and teachers.

Finally, a larger-scale evaluation, including several rural and urban institutions, would allow a better understanding of the overall impact of this solution and to refine its adaptation to different contexts. These perspectives show that although significant progress has been made, there are still several avenues to be explored to maximize the impact of digital tools and Business Intelligence in improving education systems in the DRC, while taking into account the specific realities of rural areas.

References

[1]. Badir, Hassan. "UML Class Diagrams And Database Design", N.D.
[2]. Baltus, Jean. "Aspect-Oriented Programming: Presentation And Application In A Distributed System". In Mini-Workshop: Cooperative Systems. Matière Approfondie, 2001. Https://Staff.Info.Unamur.Be/Ven/Cisma/FILES/2002-Baltus.Pdf.

[3]. Benali, Mourad, Mohammed Blej, And Abdellah Zerouali. Practical Guide To Evaluation In Distance Education, 2023.

[4]. Booch, Grady, James Rumbaugh, And Ivar Jacobson. The UML User Guide. Vol. 3. Eyrolles, 2000. Https://Fntic.Univ-Ouargla.Dz/Images/Biblio/Backup_2/Infopdf/639.Pdf.

[5]. "UML Class Diagrams - Google Scholar". Accessed April 19, 2025. Https://Scholar.Google.Com/Scholar?Hl=Fr&As_Sdt=0%2C5&Q=Diagrammes+De+Classes+UML+&Btng=

[6]. Faisandier, Alain. « Complex System Needs And Requirements Engineering: Complete Brief | Techniques De l'Ingénieur", 8 August 2024. Https://Www.Techniques-Ingenieur.Fr/Fiche-Pratique/Innovation-Th10/Deployer-L-Innovation-Dt30/Ingenierie-Des-Besoins-Et-Des-Exigences-D-Un-Systeme-Complexe-0270/.

[7]. Henri, Isaac. "The Digital Enterprise: Challenges And Consequences Of New Information Systems - HAL-SHS - Human And Social Sciences". Revue Française De Gestion, 2000. Https://Shs.Hal.Science/Halshs-00156575/.

[8]. IBM. « Diagrammes De Classes - Documentation IBM », 5 Mars 2021. Https://Www.Ibm.Com/Docs/Fr/Dmrt/9.5.0?Topic=Diagrams-Class.

[9]. Krob, Daniel. "Elements Of Architecture Of Complex Systems". Complexity And Information Management In Large Critical Systems, 2009, 179207.

[10]. Lamy, Jean-Pierre. "Sysml, A Model Language". Journal Technology 179 (2012): 3248.

[11]. Mazunze, Bertin. Smart Waste Management By The Internet Of Things In The DRC: A Connected And Practical Solution To Optimize Urban Waste Management. European University Publishing, 2025. Https://My.Editions-Ue.Com/Catalogue/Details/Fr/978-620-6-73560-1/Gestion-Intelligente-Des-D%C3%A9chets-Par-L%E2%80%99internet-Des-Objets-En-Rdc.

[12]. N'da, Paul. Research And Methodology In Social Sciences And Humanities: Successfully Complete Your Thesis, Master's Or Professional Dissertation, And Your Article. Bod-Books On Demand, 2024.

[13]. Paludetto, Mario, Jérôme Delatour, And Adel Benzina. "UML And Petri Nets." Tech. Sci. Informatique 23, No. 4 (2004): 54367.

[14]. Piechocki, Laurent. "UML, The Unified Object Modeling Language". Laurentpiechnocki. Develop. COM 18 (2007). Https://Www.Mcours.Net/Cours/Pdf/Leilclic1/Leilclic586.Pdf.

[15]. Quatrani, Terry. UML Modeling With Rational Rose 2000. Eyrolles, 2000. Https://Coursinfopdf.Com/Remo-Pdf/Cours-Info.370.Pdf.

[16]. Rolland, Colette, And André Flory. "The Design Of Information Systems: State Of The Art And New Perspectives". In Proceedings Of The Inforsid Congress, 340, 1990. Https://Www.Academia.Edu/Download/76202182/Texte-Rolland-Flory.Pdf.

[17]. Roques, Pascal. UML 2.5 By Practice: Case Studies And Corrected Exercises. Editions Eyrolles, 2021.

[18]. Simonin, Jacques. "(PDF) System Architecture Design Driven By A Functional Urban Planning Model." Accessed April 19, 2025. Https://Www.Researchgate.Net/Publication/46015945_Conception_De_L%27architecture_D%27un_Systeme_Dirigee_Par_Un_Modele_D%27urbanisme_Fonctionnel.

[19]. Tisluck, Gabriel. "Development Of A Competitive Intelligence Tool Useful For Strategic Management In Smes", 2014. Https://Savoirs.Usherbrooke.Ca/Handle/11143/6031.

[20]. Wautelet, I, Laurent Louvigny, And Manuel Kolp. "Unified Process As An IT Project Management Methodology". Thesis-Project, Catholic University Of Louvain, 2003. Https://Dial.Uclouvain.Be/Downloader/Downloader.Php?Pid=Boreal:5460&Datastream=PDF_01.