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# A Decision Support System for Faculty Performance Management: A Case Report using Statistical Analysis, Text Mining, and Artificial Intelligence

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***Abstract:***

***Purpose:*** This study presents a management methodology for comprehensively evaluating teaching performance by integrating statistical analysis of quantitative data, sentiment mining from text, and artificial intelligence tools. The objective is to provide academic managers with a robust and efficient diagnostic system that enables the continuous improvement of educational quality through the systematic identification of faculty strengths and areas for improvement, thereby facilitating the decision-making process in academic management.

***Design/methodology/approach:*** The research adopts an Action Research approach, developing and implementing the EvalúaPro application using MATLAB® App Designer. Student evaluations from the 2425-1 (September-December 2024), 2425-2 (January-April 2025) and 2425-3 (April-July 2025) academic periods were analyzed, which included quantitative (Likert scale questions) and qualitative (open-ended comments) components. For the 2425-1 period, 362 evaluations were analyzed, corresponding to 30 sections of 21 courses taught by 20 faculty members. For the 2425-2 period, 338 evaluations from 33 sections of 24 courses taught by 24 faculty members were processed, and for the 2425-3 period, 447 evaluations were analyzed, corresponding to 31 sections of 24 courses taught by 23 faculty members. All participants belonged to a department within the engineering faculty. Teaching competencies were strategically categorized into Soft Skills (Effective Communication, Interpersonal Skills, Time Management, and Organization) and Technical/Professional Skills (Content Mastery, Teaching Methodology). The qualitative analysis implemented the VADER algorithm for sentiment mining, while descriptive statistics were used for the quantitative analysis. Validation included tests with department heads to assess the application's effectiveness as a management tool.

***Findings:*** The methodology proved highly effective for the managerial diagnosis of teaching performance, facilitating the identification of patterns at both individual and departmental levels. In the validation with department heads, 87.5% "agreed" or "strongly agreed" that the information presented by the prototype facilitates decision-making regarding faculty support, monitoring, and evaluation (37.5% "strongly agree," 50% "agree," 6.3% "neither agree nor disagree," 6.3% "strongly disagree"). Regarding the generated improvement plan, 93.8% of department heads "agreed" or "strongly agreed" that it accelerates feedback to faculty (43.8% "strongly agree," 50% "agree," 6.3% "strongly disagree"). Concerning its utility for diagnosis and decision-making for continuous improvement, 87.5% expressed they "agreed" or "strongly agreed" (62.5% "strongly agree," 25% "agree," 12.5% "neither agree nor disagree"). The system generated personalized improvement plans for faculty with scores below 3.0 and departmental strategies when more than 25% of professors showed similar areas for improvement. Furthermore, the system translates its integrated data analysis into a predictive tool, automatically alerting managers to signs of student dissatisfaction and thereby facilitating preemptive support measures.

***Research limitations/implications:*** The main limitations include adapting the VADER algorithm for the specific academic context and requiring constant feedback to refine the artificial intelligence algorithms. Further research is required to validate the effectiveness of the automatically generated improvement plans in subsequent academic periods and their impact on improving teaching performance.

***Practical implications:*** The methodology significantly reduces academic managers' time analyzing teaching evaluations, enabling faster and more specific feedback. The system facilitates identifying specific training needs that institutional resources, such as the Teaching Center, can address, thereby improving the efficiency of academic human resource management.

***Social implications:*** Implementing this methodology enhances the analysis of educational evaluation, ensuring that student opinions are systematically considered for continuous institutional improvement, which can potentially reduce student attrition and enhance the overall educational experience.

***Originality/value:*** This methodology represents an innovation that improves educational management by integrating advanced data analysis tools with structured managerial processes. The holistic approach, which combines statistical analysis, text mining, and artificial intelligence for faculty evaluation, offers significant value to educational institutions seeking to implement evidence-based continuous improvement systems. The strategic categorization of skills and the automatic generation of personalized improvement plans constitute an original contribution to educational management.

***Keywords:*** educational management, faculty evaluation, sentiment analysis, artificial intelligence, continuous improvement, text mining, academic performance, decision-making, case report paper, action research

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## 1. Introduction

Modern management in educational institutions faces the constant challenge of evaluating competitive performance efficiently and reliably, requiring robust indicators and evaluation systems for continuous improvement (Poveda-Bautista et al., 2012, 2013). In the educational context, this implies that managers must implement systematic strategic planning processes to identify strengths, opportunities, weaknesses, and threats, thereby grounding decision-making in pursuing enhanced institutional performance.

Among the multiple responsibilities of educational management, faculty evaluation and development stand out as a critical process, as they are key determinants of educational service quality and fundamental objectives from a strategic management perspective. According to Zurita (2018), strategic management acts as a transformative tool in educational administration, enabling stakeholders' prominent and effective participation in the educational process, the implementation of institutional plans, and the recurrent evaluation of outcomes. This strategic vision is essential when evaluating faculty performance, a process that must be approached from a comprehensive perspective that considers both quantitative and qualitative aspects.

Faculty performance evaluation, based on student feedback, serves as a strategic management tool through which academic leaders periodically monitor the pedagogical effectiveness of their instructors (Carranza-Basantes et al., 2024). As Husain and Khan (2016) indicated, student feedback is an effective tool in the faculty evaluation system, providing valuable information for educational management. In line with this managerial vision, Universidad Metropolitana, a private higher education institution in Caracas, Venezuela, promotes student participation in evaluating its faculty. This is implemented by administering surveys to collect information on quantitative and qualitative criteria related to important aspects for monitoring faculty performance. The quantitative methods, which consist of closed-ended questions, provide numerical data that is readily comparable.

One survey component is an open-ended question designed to probe student perceptions of faculty performance, inviting them to express their opinions freely. This method yields more detailed insights into student perspectives (Aznar-Mas et al., 2023). The central idea underlying the instrument's design is that while quantitative data provides a general overview, qualitative information allows a deeper dive into student perceptions by analyzing their written arguments, offering a more complete and useful understanding for teaching improvement.

Analyzing student sentiment helps identify strengths and weaknesses in course organization and teaching effectiveness. It can also highlight student dissatisfaction and potential needs for enhancing the overall quality of the educational experience. A combined analysis of closed-ended questions and free-text responses generates more effective insights. This allows educational institutions to monitor faculty performance for administrative purposes, adjust course evaluation design, and potentially limit student attrition.

Although student comments provide diagnostic feedback to instructors, allowing them to self-assess their teaching style and performance, the analysis of this information by academic managers responsible for faculty oversight presents a significant challenge. It demands a substantial time investment, as managers must analyze large volumes of text while cross-referencing it with quantitative data from closed-ended responses. This process often leads to the underutilization of the valuable feedback from students.

This challenge underscores the need to develop innovative managerial methodologies integrating statistical analysis, text mining, and artificial intelligence (AI). Systematically detecting and managing information on student perceptions allows for identifying strengths and weaknesses in course organization and teaching effectiveness, enabling timely, evidence-based managerial interventions. As Misuraca et al. (2021) point out, the integrated analysis of quantitative and qualitative data yields more effective evaluations, facilitating the monitoring of faculty performance for administrative and strategic purposes.

In this context, and as part of the continuous improvement initiatives at Universidad Metropolitana (UNIMET), the present study proposes an innovative managerial methodology for the comprehensive evaluation of faculty performance, embodied in a software prototype named EvalúaPro. This tool was created to provide a more robust diagnosis by applying techniques such as sentiment mining and artificial intelligence to enhance the analysis of faculty evaluation results and obtain detailed information on teaching strengths and weaknesses. Sentiment mining is performed using the VADER (Valence Aware Dictionary and sEntiment Reasoner) algorithm within the MATLAB development environment (Asthana et al., 2024; Baur, 2023; Hutto & Gilbert, 2014; Yeo, 2017). This process generates numerical representations from the open-ended responses, which then serve as input for creating word clouds that characterize student opinion, not only by rating but also by classification, from the lowest to the highest-scoring evaluations. The proposed approach seeks to optimize the time academic managers dedicate to analyzing evaluations and increase the strategic value of the information obtained, thereby facilitating effective decision-making to improve educational quality continuously.

Consequently, to structure this managerial intervention, the study adopts an Action Research approach presented as a Case Report. This format adheres to the guidelines for reporting case studies and action research in Business Management (Marin-Garcia et al., 2022), ensuring a comprehensive narrative that spans from the problem diagnosis to the development of the artefact (EvalúaPro) and the observed outcomes. Furthermore, the study aligns with the framework for teaching experiences based on action research (Marin-Garcia & Alfalla-Luque, 2021), utilizing a cyclic process of planning, acting, observing, and reflecting to support educational quality through data-driven decision systems

This managerial innovation aligns directly with the Sustainable Development Goals, specifically SDG 4 (Quality Education), by establishing a mechanism for the continuous improvement of teaching performance in high-demand learning environments (Benhayón-Benarroch & García, 2006; Briceño-Marcano & Herrera, 2018;

Certad, 2010; Marcano et al., 2025). By engaging in a detailed analysis of faculty strengths and weaknesses, the methodology ensures that the instruction provided meets rigorous academic standards. Furthermore, by integrating artificial intelligence and text mining into administrative processes, the project supports SDG 9 (Industry, Innovation, and Infrastructure). It demonstrates how modern technological tools can optimize the time and resources of academic managers, ensuring that decision-making is efficient, sustainable, and focused on the real needs of the educational community.

## 2. Literature Review

### 2.1. Educational Management and Faculty Performance Evaluation

Effective educational management requires tools that facilitate communication and information analysis for strategic decision-making. Zurita (2018) points out that strategic management serves as a transformative tool in educational administration, enabling stakeholders' prominent and effective participation in the implementation of institutional plans. This strategic approach is particularly relevant for evaluating faculty performance, which must be coherently integrated with institutional goals for academic quality.

From a managerial perspective, faculty evaluation is a systematic process of collecting and analyzing information to assess teaching performance quality, identify improvement areas, and design professional development strategies. Student evaluation of teaching performance must be supported by valid inferences about instructor effectiveness and serve as one of several managerial evaluation tools (Yu, 2016), as it is a fundamental component of educational quality assurance systems.

Husain and Khan (2016) highlight that student feedback is an effective tool within the faculty evaluation system, providing valuable information for educational management. This feedback measures teaching quality and significantly influences student academic outcomes (Lizzio et al., 2002). Gaertner (2014) demonstrates that student feedback is effective as a self-assessment method for improving teaching quality. Wong and Chapman (2023) establish a link between student satisfaction, effective interaction, and learning outcomes.

From an administrative management standpoint, when systematically implemented, faculty evaluation enables educational institutions to assess their departmental efficiency and identify specific areas for improvement (Agha et al., 2011). This aspect is crucial for educational managers, who must leverage the information gathered to optimize resource allocation and strategically guide the professional development efforts of their faculty.

### 2.2. Quantitative and Qualitative Aspects in Faculty Evaluation

Universities have traditionally emphasized the quantitative component of student evaluations, as this data is easily summarized and analyzed using conventional statistical techniques. These evaluations typically include closed-ended questions, frequently utilizing the Likert scale, which are subsequently employed for the managerial evaluation of faculty (Misuraca et al., 2021).

Conversely, the qualitative component of evaluations—particularly open-ended questions where students freely express their opinions—provides contextually relevant information that significantly complements the quantitative data. Aznar-Mas et al. (2023) demonstrated the importance of including open-ended questions in faculty evaluations, finding that these uncover aspects of performance that closed-ended questions fail to capture. Pereira et al. (2016) note that the effectiveness and relevance of feedback in higher education depend heavily on its ability to generate detailed and contextualized information. Qualitative feedback reflects students' feelings and perceptions toward the course and the instructor, providing valuable insights into the established pedagogical relationship (Gaertner & Brunner, 2018).

### 2.3. Sentiment Mining and Artificial Intelligence in Educational Evaluation

Analyzing comments using opinion mining or sentiment analysis techniques represents a significant innovation in educational evaluation. Hutto and Gilbert (2014) developed VADER, a parsimonious, rule-based model for sentiment analysis in texts, which has proven highly effective in classifying opinions (Borg & Boldt, 2020; Isnan et al., 2023). Asthana et al. (2024) highlighted that VADER is a lightweight and effective approach for sentiment analysis across multiple contexts, including the educational sphere. Visualizing these analyses through positive and negative word clouds facilitates the rapid identification of areas for improvement or strengths to be highlighted in faculty performance (Misuraca et al., 2021). Baur (2023) demonstrates how sentiment analysis can extract valuable information even from large volumes of unstructured text, allowing for the identification of patterns and trends that are difficult to detect using manual methods.

In EvalúaPro, sentiment analysis is employed as an analytical tool to automatically evaluate the free-text comments provided by students in faculty evaluations. This technique makes it possible to assess the fulfillment of student expectations regarding teaching performance and the quality of academic management, including content, teaching materials, assessment methods, and learning outcomes (Misuraca et al., 2021). The analysis is conducted on two complementary levels: at a global level, where the overall orientation of the comment is determined, and at the sentence level, where each comment is segmented into its constituent parts to calculate individual polarities that are then averaged (Hutto & Gilbert, 2014). The polarity scores are interpreted as indicators of the student's emotional state regarding their educational experience, where scores close to +1 reflect positive feelings, values near -1 indicate negative perceptions, and those close to 0 suggest neutrality (Asthana et al., 2024). The VADER algorithm is based on a sentiment lexicon composed of words annotated with specific polarity values. This system is complemented by lists of terms that influence the analysis: intensifiers, such as 'incredibly,' amplify the sentiment; diminishers, like 'barely,' reduce it; and negations, such as 'is not,' invert the polarity of subsequent words (Asthana et al., 2024; Baur, 2023; Borg & Boldt, 2020; Misuraca et al., 2021). Additionally, Misuraca et al. (2021) note that visualizing these analyses through intuitive graphical representations like word clouds facilitates the managerial interpretation of the results.

Furthermore, artificial intelligence transforms continuous improvement processes in educational management by providing sophisticated tools for analyzing faculty performance and student feedback. Machine learning algorithms enable instructors to systematically monitor student performance and implement preventive measures to support struggling students (Hooda et al., 2022). Hooda et al. (2022) point out how AI allows for the construction of systems that assess learning and provide immediate feedback that significantly enhances student success in higher education. Personalized feedback systems based on AI analyze students' academic interactivity and collaborative behaviors, establishing feedback processes tailored to each class. Therefore, implementing AI in student evaluations of teaching will allow educational institutions to more effectively monitor faculty performance, adjust curriculum design, and reduce student attrition, transforming diagnostic feedback into a powerful tool for faculty self-assessment and continuous improvement.

Finally, the design of tailor-made applications in the educational field has been of great assistance in the teaching-learning process (Pérez-Hernández, 2022; Rosales-Anzola & Pérez-Hernández, 2023). For these tools to be effective, aligning pedagogy and technology during their development is crucial, prioritizing the educational purpose over technical functionality (Børte & Lillejord, 2024). This same principle of customized design extends to educational management, where specialized applications must be adapted to the specific needs of institutional evaluation and administration. In the managerial context, aligning institutional objectives and technological functionality becomes essential for developing tools that effectively support faculty evaluation processes, performance monitoring, and administrative decision-making. The development of these managerial tools must follow an iterative process with cycles of development, testing, and improvement where educational administrators, academic coordinators, and software developers collaborate (Wasson & Kirschner, 2020).

Thus, modern educational administration incorporates multiple resources for planning and decision-making grounded in the verification of service quality levels within modern educational organizations (Chiavenato, 2013). In this regard, the objective of this work is grounded in the need to provide educational managers with tools that implement advanced methodologies for data analysis in the context of faculty evaluation, thereby facilitating the fulfillment of their administrative responsibilities for diagnosis, feedback, monitoring, and continuous improvement. This is achieved through the effective integration of statistical analysis of numerical data with sentiment mining and AI to enhance the faculty evaluation process, through the design of the EvalúaPro application.

### 2.4. Strategic Categorization of Teaching Skills for Managerial Evaluation

Effective teaching performance management requires a conceptual framework to organize the diverse dimensions of teaching systematically. In this context, the specialized literature has proposed various categorizations of the skills necessary for effective teaching, which can be adapted for managerial purposes.

Regarding soft skills, Bhatnagar and Mamta (2011) highlight effective communication as a fundamental component of teaching performance, noting that explanatory clarity and responsiveness are key indicators of effectiveness. Bravo-Alvarado (2021) and Tafur-Ruiz (2023) reaffirm that these communication skills are essential for establishing a productive pedagogical relationship, while Bello (2019) positions them as central elements in educational management.

Concerning interpersonal skills, De-La-Ossa (2022) and Fernandes et al. (2021) point to their importance in creating participatory and respectful learning environments. MacCann et al. (2012) address time management and organization as transversal competencies that significantly influence teaching effectiveness and student perception.

About technical/professional skills, Lizzio et al. (2002) and Flumerfelt & Kahlen (Flumerfelt & Kahlen, 2015) emphasize content mastery as a determining factor in student satisfaction and learning outcomes. Webb and LoFaro (2020) add that this mastery must be coherently reflected in the implemented assessment methods.

Teaching methodology constitutes another essential component of technical skills, analyzed by Tuunila and Pulkkinen (2015) and Mann et al. (2011) as a decisive factor in teaching effectiveness. John and Catherine (2011) and Oerther (2022) highlight the importance of using practical examples and facilitating the review of assessments as part of an effective methodology.

This strategic categorization allows educational managers to systematically evaluate teaching performance and design specific interventions for different competency areas, thereby optimizing the resources dedicated to professional development.

## 3. Sample and Methodology

### 3.1. Research Design

The study employed an Action Research approach, characterized by the authors' active participation in the experiment through a collaborative, continuous improvement process. This method is particularly relevant for addressing educational management problems, as it facilitates the creation of practical, contextualized solutions tailored to the institution's specific needs. This method has also been adopted in Software Engineering for requirements elicitation, emphasizing that the researcher assumes the role of a requirements engineer or consultant, immersing themselves in the organization's business processes to identify the genuine needs of various stakeholders and thereby more accurately define the functional requirements of the system to be built, seeking to automate one or more business processes (Dos-Santos & Travassos, 2009).

In this study, the faculty performance evaluation process was specifically observed from the perspective of academic managers responsible for monitoring teaching quality and analyzing results to guide the continuous improvement of faculty at the Faculty of Engineering of Universidad Metropolitana. As a result, the following use cases were identified: Data Loading, Diagnosis, and Improvement Plan Construction, Figure 1. The Data Loading use case allows the actor (Academic Manager) to input data into the system from the surveys administered to students by the Human Capital office. The Diagnosis use case offers the Academic Manager a set of functionalities to review the evaluation results for each faculty member, as well as a tentative improvement plan. The system executes a heuristic that integrates quantitative and qualitative information analysis mechanisms to provide this information. In the Improvement Plan Construction use case, the Manager accesses a set of AI-generated recommendations, which they can modify and adapt before presenting them to the faculty member to establish achievable goals for continuous teaching improvement.

It is important to note that while an initial set of requirements was gathered using the action-research approach, their refinement followed an iterative and incremental dynamic based on the OpenUp software development methodology (Borg et al., 2007; Daraojimba et al., 2024). Accordingly, a series of iterations was conducted, in which prototype functionalities were implemented and presented to end-users for partial verification. This led to successive refinements of the requirements, which were added to the work backlog and addressed in subsequent iterations until a stable requirements model was achieved, allowing researchers to focus on solution design and functional enhancements to the prototype. Nevertheless, once a minimum viable product (MVP) of the prototype was obtained, system or E2E (End-to-End) testing (Al-Ahmad & Debei, 2020) and acceptance testing (Tong et al., 2022) were conducted. The study focuses on a specific academic unit within the Faculty of Engineering, which constitutes one of the largest and most complex divisions of the institution. This department was purposively selected as the pilot environment due to its operational complexity and identified performance gaps. It manages the highest academic load among the faculty's four departments, overseeing 31.25% of the total course offerings (45 out of 144 subjects). This scenario provided the ideal conditions to use EvalúaPro not just as a monitoring tool, but as an active intervention mechanism.

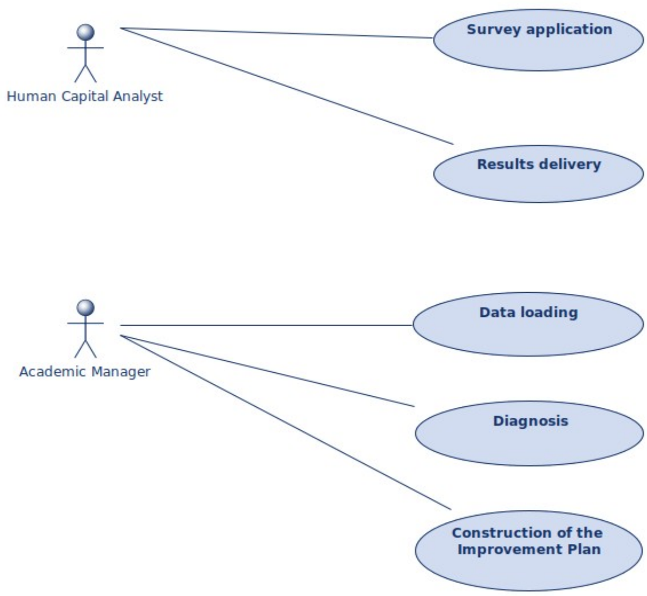


*Figure 1. Use cases for the faculty performance evaluation process*

For the system tests, the primary input consisted of student evaluations of teaching performance from the 2425-1 academic period (September to December 2024), the 2425-2 academic period (January to April 2025) and 2425-3 academic period (April to July 2025). These evaluations were institutionally administered to students at the end of each academic term, following a standardized protocol that ensured participant anonymity and data reliability.

The total sample comprised evaluations from one department within the Faculty of Engineering, analyzing 30 sections corresponding to 21 courses and 362 evaluations for 20 faculty members for the 2425-1 period. For the 2425-2 period, 33 sections corresponding to 24 courses and 338 evaluations for 24 faculty members were analyzed. Finally, for the 2425-3 period, 31 sections corresponding to 24 courses and 447 evaluations for 23 faculty members were analyzed. This dataset, therefore, covers three consecutive academic terms within the same departmental context. The courses belonged to the chemical, electrical, and mechanical engineering programs. This purposive sampling was based on disciplinary representativeness and complete data availability, enabling the implementation and validation of the proposed methodology.

The evaluation instrument used for data collection consists of two main sections:

- Quantitative component: 16 closed-ended questions evaluated on a 4-point Likert scale (4-Strongly agree, 3-Agree, 2-Disagree, 1-Strongly Disagree, NA/NR-Not Applicable/No Response), distributed as follows:
  - 14 items on teaching performance (explanatory clarity, organization, subject mastery, use of examples, responsiveness to questions, fostering participation, attitude towards students, punctuality, consistency

in assessments, adherence to the evaluation plan, timeliness of feedback, review of assessments, overall satisfaction).

- ○ 1 item on the assessment of knowledge increase (scale: 4-Very high, 3-High, 2-Average, 1-Low).
- ○ 1 item on student satisfaction (willingness to take another course with the professor, course met learning expectations, student performance self-assessment).

- Qualitative component: A free-text section where students could express additional opinions about the instructor's performance or other relevant aspects.

Furthermore, acceptance testing was conducted with 16 department heads representing the faculties of law and political studies, humanities, sciences, and economic and social sciences at the University. They could interact with the system prototype, accessing the information derived from processing the results obtained during the system (E2E) tests. Subsequently, they were administered a survey to explore the prototype's functional relevance.

## 4. Results

### 4.1. Development of the Managerial Methodology and the EvalúaPro Application

The EvalúaPro application was developed using MATLAB® App Designer, a development environment that provides both layout and code views (Guzan et al., 2020; Hamel & Rosales-Anzola, 2024; MathWorks, 2025; Pérez-Hernández, 2022; Rosales-Anzola & Pérez-Hernández, 2023; Rosales-Anzola & Urbina-Villalba, 2024). Figure 2 shows the main screen of the application.

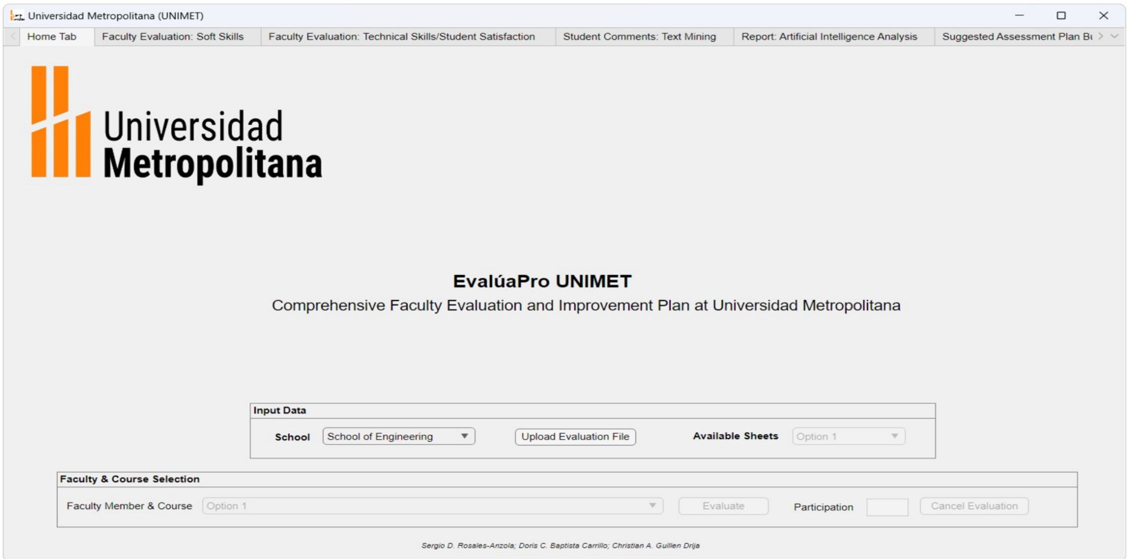


*Figure 2. Main interface of the EvalúaPro App*

This tool was designed to support the managerial functions of evaluation, diagnosis, and continuous improvement of faculty performance. The tool processes data from the institutional evaluation instrument.

The development and deployment of the solution followed a rigorous 10-week timeline of intensive multidisciplinary work. This comprehensive process encompassed the full lifecycle of the intervention, ranging from the literature review for competency categorization to the requirement elicitation with the Dean of Engineering and the Human Capital Office. The core engineering effort focused on two critical tasks. First, the team performed an iterative calibration of the VADER sentiment analysis lexicon to ensure accurate polarity detection in a multilingual context. Second, the developers implemented an automated reporting module capable of generating individual Microsoft Office documents that consolidate evaluation metrics, statistical comparisons against departmental benchmarks, and personalized improvement plans. Once this extensive development phase was completed, the system achieved high operational efficiency, where the data processing engine, comprising VADER sentiment analysis, word cloud generation, and descriptive statistics, analyzes the entire semester dataset in less than 180 seconds. Subsequently, the Artificial Intelligence module consumes these processed results to cross-reference identified gaps with the Teaching Center's training catalog, automatically generating a SWOT analysis and a tailored professional development plan for each faculty member. Furthermore, the protocol included a feedback loop where results from the 2425-1 pilot were analyzed to implement architectural refinements for the 2425-2 period.

#### 4.1.1. Data Loading Use Case

A strategic categorization was conducted to implement this use case. From a managerial perspective, the survey questions were grouped into Soft Skills and Technical/Professional Skills, which were divided into subcategories. This framework was designed to enable a more precise diagnosis of teaching performance, resulting in the following structure:

Soft Skills:

- Effective Communication (Bello, 2019; Bhatnagar & Mamta, 2011; Bravo-Alvarado, 2021; Tafur-Ruiz, 2023; Wong & Chapman, 2023):
  - Explains content clearly.
  - Responds to questions promptly.
  - I am satisfied with the professor's performance.
- Interpersonal Skills (De-La-Ossa, 2022; Fernandes et al., 2021):
  - Encourages student participation in class.
  - Maintains a receptive and respectful attitude towards students.
- Time Management (MacCann et al., 2012):
  - Adheres to the class schedule punctually.
  - Returns evaluation results within a reasonable timeframe.
- Organization (MacCann et al., 2012):
  - Conducts classes in an organized and structured manner.
  - Follows the established assessment plan.

Technical/Professional Skills:

- Content Mastery (Flumerfelt & Kahlen, 2015; Lizzio et al., 2002; Webb & LoFaro, 2020):
  - Demonstrates mastery of the subject matter.
  - Assessments are consistent with the level of content taught in class.
- Teaching Methodology (John & Catherine, 2011; Mann et al., 2011; Oerther, 2022; Tuunila & Pulkkinen, 2015):
  - Uses examples, exercises, and problems to enhance learning.
  - Facilitates the review of assessments.
  - Assesses the increase in knowledge, competencies, and/or skills acquired.

Furthermore, Data Import and Preprocessing were implemented. The evaluation data is imported into the system designed to identify and properly manage missing values. These can occur in two forms: in the quantitative section as "NA/NR" (Not Applicable/No Response) answers, which students can select when they are unable or unwilling to evaluate a specific item; and in the qualitative section, where open-ended comments are optional and may therefore be present or absent.

#### 4.1.2. Diagnosis Use Case

The implementation of this use case entailed the development of algorithms for the following functionalities:

- Statistical analysis of quantitative data, calculating each item's minimum, first quartile, median, third quartile, maximum, and average.

- Sentiment analysis of free-text comments using the VADER algorithm, adapted for the educational context.
- Visualization through statistical charts and sentiment-differentiated word clouds.

In the quantitative analysis, the numerical data from the evaluations are processed by calculating descriptive statistics (minimum, first quartile, median, third quartile, maximum, and average) for each item and subcategory, as previously specified. These results are presented graphically and compared against departmental averages to contextualize individual performance. By way of illustration, Figures 3 and 4 present the results for the Soft Skills and Technical/Professional Skills categories, as evaluated for a specific instructor and course. The overall evaluation score is 2.93, close to the established threshold of 3.0.

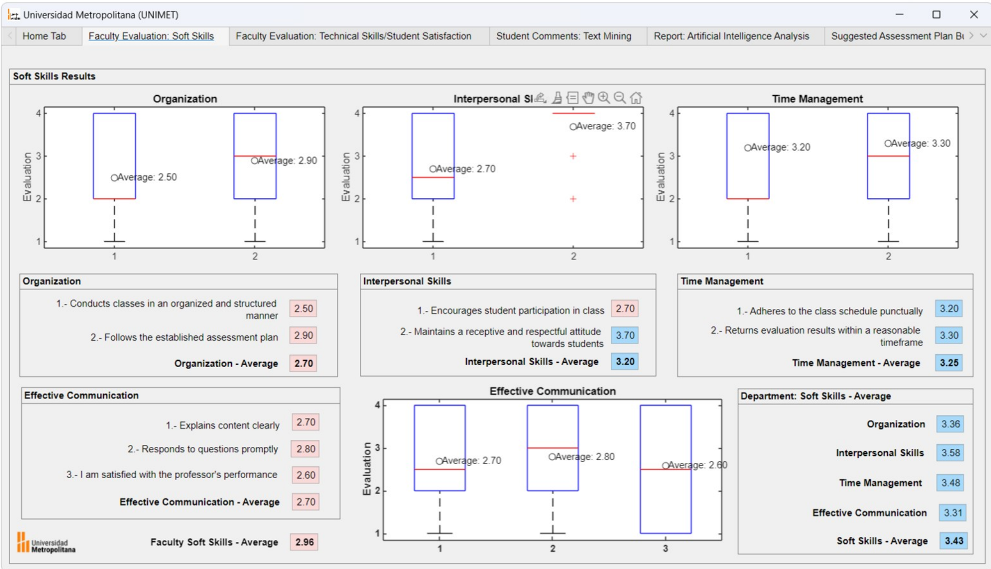


*Figure 3. Results view: Soft Skills*

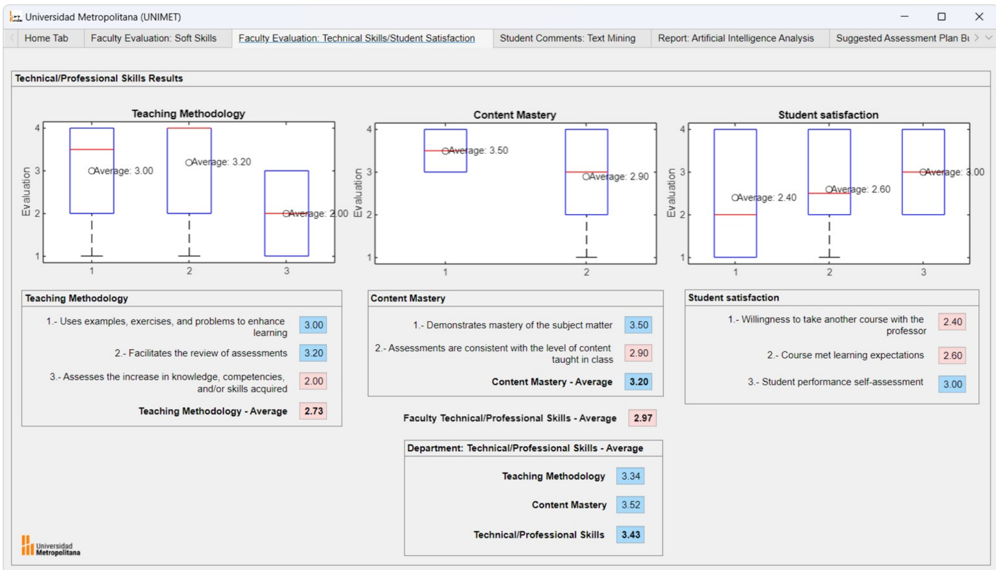


*Figure 4. Results: Technical/Professional Skills*

For the qualitative analysis, free-text comments from course evaluations are processed through the following stages. If no comments are provided, this analysis is bypassed:

1. Tokenization and normalization (conversion to lowercase, removal of punctuation).
2. Lemmatization to reduce morphological variability.
3. Stop-word removal.
4. Assignment of a polarity score to each comment using the VADER algorithm.
5. Generation of a bag-of-words for positive and negative comments.
6. Generation of distinct word clouds from the positive and negative bags-of-words.

Figure 5 presents the quantitative assessment of the sentiment analysis of the comments. In this case, the result indicates a predominantly neutral sentiment, accompanied by its respective word clouds.

Once both the quantitative and qualitative analyses are complete, the system presents the user with an integrated view that displays:

- An individual diagnosis per instructor and course, identifying strengths and areas for improvement.
- A departmental diagnosis, identifying common patterns and performance distributions.
- A student attrition risk analysis based on critical indicators.

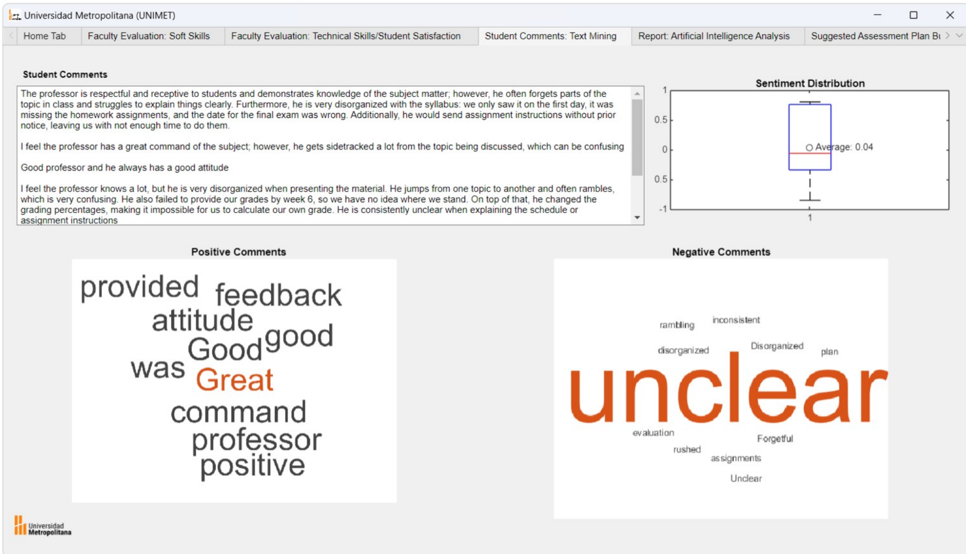


*Figure 5. Sentiment analysis evaluation and graphical representation via word clouds*

### 4.1.3. Improvement Plan Construction Use Case

EvalúaPro provides a diagnosis based on student evaluation results and offers academic managers a preliminary action plan to guide faculty members who have scored below 3.0. This plan helps them adopt corrective actions aimed at improving their performance. This is complemented by generating departmental plans when more than 25% of the faculty exhibit similar areas for improvement. Furthermore, it provides training recommendations tied to the professional development offerings that the institution provides to its faculty as part of its institutional policies. Finally, the application automatically generates SWOT analyses and personalized improvement plans using artificial intelligence algorithms.

It is necessary to state that EvalúaPro facilitates the creation of an improvement plan covering both soft and technical skills in teaching performance by enabling the collection and analysis of relevant data.

The Improvement Plan for Faculty Soft Skills design is based on student evaluation results, which include closed-ended questions and free-text areas. These evaluations are structured around four key skills: Effective Communication, Interpersonal Skills, Time Management, and Organization, each assessed through specific performance indicators. The results are analyzed using artificial intelligence, considering numerical values to determine whether scores meet the University's established target. When scores fall below 3.0, an improvement plan is proposed; if they exceed this threshold, the faculty member is commended for their performance, and no plan is generated.

The Improvement Plan is structured as a framework of concrete, measurable actions designed to strengthen the areas for improvement identified in the evaluation. For each skill needing enhancement, the plan details up to three specific activities directly aligned with the identified weaknesses. These actions are supported by strategic institutional resources, primarily through the Teaching Center, the university unit dedicated to the continuous professional development of faculty, which offers a quarterly portfolio of workshops and diploma programs to enhance teaching competencies. The plan links the identified needs with the relevant training offerings from the center. Each proposed activity has an estimated implementation timeframe of up to 12 weeks, ensuring its feasibility within the academic cycle. Additionally, the plan incorporates complementary resources, such as academic assistantships for specific tasks like improving teaching materials and integrating them into the professional development process. This systematic structure ensures the plan is effective, personalized, and strategically focused on strengthening the instructor's soft skills, aiming to optimize their interaction with students and fulfill their academic responsibilities.

The design of the Improvement Plan for Faculty Technical/Professional Skills is based on the results from student evaluations, which include closed-ended questions and free-text areas. These evaluations focus on Content mastery and teaching methodology, which are assessed through specific indicators. For Content Mastery, the analysis covers the instructor's ability to demonstrate command of the subject and the alignment between the level of assessments and the content explained in class. For Teaching Methodology, the evaluation considers using practical examples and exercises to optimize learning, facilitating assessment reviews, and focusing on increasing students' acquired knowledge and skills. These results are compared against the standard set by the University (a minimum score of 3.0), using artificial intelligence tools to identify strengths and areas for improvement.

The improvement plan comprises concrete actions designed to enhance areas that scored below the established target. Each plan includes at least three specific activities, such as participation in workshops, diploma programs, or personalized courses offered by the Teaching Center, focused on strengthening the instructor's technical and methodological competencies. These activities specify the necessary resources and implementation deadlines within 12 weeks. Furthermore, requesting academic assistantships is encouraged in applicable cases, such as for improving teaching materials, to ensure a significant impact on teaching quality. This approach ensures the plan is practical, measurable, and focused on the continuous professional development of the faculty member.

Furthermore, the system's AI-driven analysis synthesizes student comments, instructor performance, and the course's position in the curriculum flowchart to identify significant levels of student dissatisfaction. This dissatisfaction is a potential indicator of attrition risk, particularly in foundational or bottleneck courses. When high dissatisfaction coincides with unsatisfactory faculty performance, the EvalúaPro application automatically alerts the relevant School Director(s) to these findings, indicating that a specific course or instructor requires immediate managerial attention. Figure 6 illustrates this automated alerting feature.

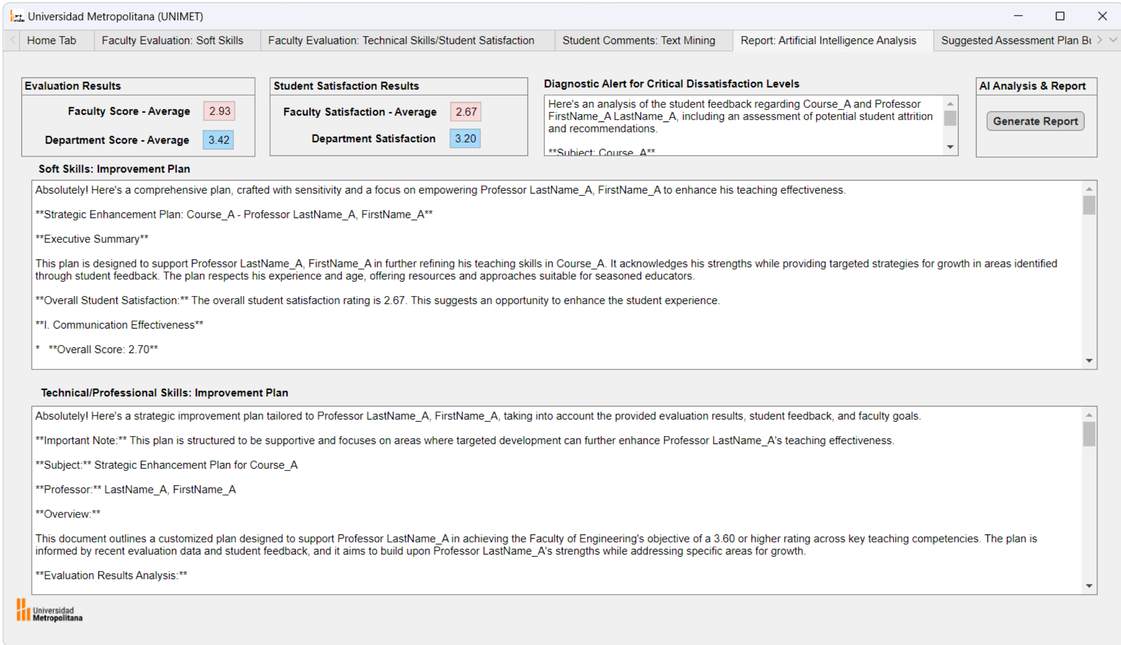


*Figure 6. The application view shows the improvement plans for skill sets and the attrition risk analysis*

### 4.2. Departmental Analysis to Identify Collective Development Needs

The analyses presented thus far are foundational to the continuous improvement process for the faculty. To assess the departmental unit holistically, a comprehensive analysis was conducted on the scores obtained by all faculty members across both soft and technical/professional skills.

To facilitate comprehension of the results, distributions for Faculty Evaluations and Student Satisfaction are generated using pie charts, identifying the percentage of faculty with scores below 3.0 in both areas. A horizontal bar chart is also developed, ranking the scores for each course and its respective instructor in ascending order. This chart visually highlights scores below the 3.0 threshold in red and those above it in blue, Figure 7.

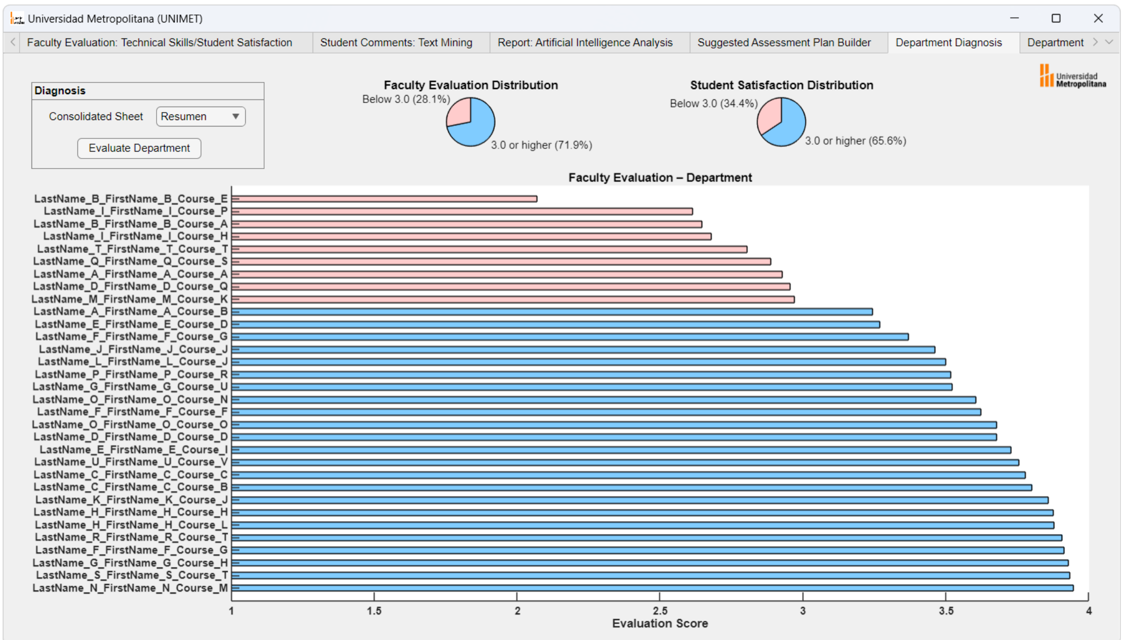


*Figure 7. Distribution of faculty results for the department, 2425-1*

A detailed analysis is performed for each Soft Skill (Effective Communication, Interpersonal Skills, Time Management, and Organization) and Technical/Professional Skill (Content Mastery and Teaching Methodology). For each competency, the departmental average is calculated and represented in pie charts, highlighting in red the percentage of faculty with scores below the 3.0 threshold and those who exceed it in blue.

To generate improvement recommendations, an artificial intelligence-based analysis system is implemented to assess the obtained results objectively. The process prioritizes areas where more than 25% of the faculty have received scores below 3.0, indicating a need for a departmental-level intervention.

Recommendations for soft skills are based on a departmental SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, considering the specific results in Effective Communication, Interpersonal Skills, Time Management, and Organization. For each area identified for improvement, a short- and medium-term action plan is proposed, which includes concrete, measurable actions tailored to the faculty's profile.

Similarly, recommendations for technical/professional skills are developed based on the results in Content Mastery and Teaching Methodology. The proposed improvement plan establishes specific actions with 12-week implementation timelines, necessary resources, and, notably, the incorporation of courses from the Teaching Center that are directly related to the identified areas for improvement. Training options include workshops on digital tools like Genially and Moodle, effective presentation techniques, active learning methodologies such as STEAM, competency-based training, and innovation with artificial intelligence. Figure 8 depicts the results obtained by the department's faculty, classified according to the Soft Skills and Technical/Professional Skills categories.

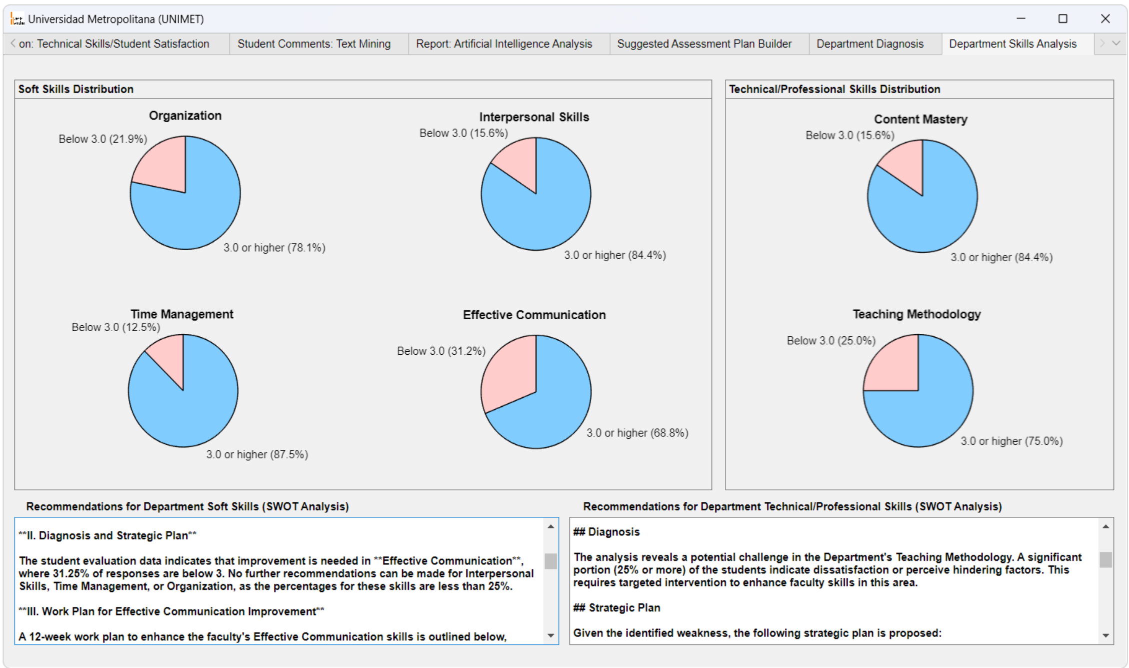


*Figure 8. Distribution and recommendations of departmental results by skill category*

## 5. Discussion of Results

### 5.1. Effectiveness of the Strategic Categorization for Managerial Analysis

The strategic categorization of teaching skills into the dimensions of Soft Skills and Technical/Professional Skills proved to be an effective framework for managerial analysis, facilitating the identification of specific areas of strength and opportunities for improvement. The analysis revealed that for Soft Skills, the subcategories with the highest scores below the 3.0 threshold were primarily Effective Communication, followed by Organization. Within the Technical/Professional Skills dimension, the Teaching Methodology subcategory exhibited the highest number of instances with scores below the established threshold, Figures 3 and 4.

This finding is particularly relevant from a managerial perspective, as it allows academic leaders to strategically channel professional development resources toward specific areas with the greatest potential for impact. The precise identification of these areas for improvement enables educational managers to implement systematic strategic planning processes.

### 5.2. Effective Integration of Quantitative and Qualitative Analysis

EvalúaPro demonstrated particular effectiveness in integrating quantitative and qualitative data, overcoming a common limitation in traditional faculty evaluation systems. The sentiment analysis applied to student comments generated complementary information that validated the quantitative results.

In a high proportion of the cases analyzed, a significant correlation was found between the quantitative scores and the sentiment polarity detected in the comments, suggesting consistency in student perceptions across both evaluation formats. However, the qualitative analysis made it possible to identify nuances and specific aspects not captured by the numerical scales.

The observed alignment between Likert-type scores and sentiment polarity supports the rationale of integrated educational analytics proposed by Misuraca et al. (2021), as mixed quantitative and qualitative workflows reduce interpretive ambiguity and increase the managerial value of student feedback when both components converge on the same diagnostic signal. Regarding the technical implementation, the adoption of the parsimonious rule-based approach described by Hutto and Gilbert (2014) demonstrated that computational efficiency in sentiment analysis does not compromise diagnostic accuracy in educational settings. While polarity scores remain conditional on the coverage and calibration of the underlying sentiment lexicon, the triangulation of numerical ratings with explainable sentiment scores strengthens the diagnostic reliability of the system. Furthermore, the analysis must be interpreted under the constraint that student evaluations are perception-based indicators rather than direct measurements of teaching effectiveness. However, the observed performance recovery, where underperformance dropped from 28.1% to 6.5%, confirms the assertion by Yu (2016) that student feedback, when systematically processed and mediated through active managerial intervention, ceases to be a passive metric and becomes a measurable catalyst for professional development.

Visualizing results through sentiment-differentiated word clouds proved useful for rapidly identifying critical aspects of teaching performance, enabling department heads to grasp the main strengths and areas for improvement in seconds (Figure 5). This managerial approach to data facilitates more agile diagnostics than traditional methods of reviewing comments. This is a crucial feature for an effective Management Information System, which, as Prieto-Herrera and Therán-Barrios (2018) point out, must adhere to principles of quality, timeliness, quantity, and relevance to facilitate decision-making and improve organizational performance.

### 5.3. Validation with Department Heads

The results from the validation with department heads, conducted through system testing, were highly positive, demonstrating the application's effectiveness as a managerial tool. Regarding the statement, "The information presented by the prototype facilitates the Department Head's decision-making regarding the support, monitoring, and evaluation of faculty members in their department," 87.5% of participants indicated they "agreed" or "strongly agreed" (37.5% "strongly agree," 50% "agree"). In comparison, 6.3% were neutral and 6.3% "strongly disagreed." These results are shown in Figure 9.

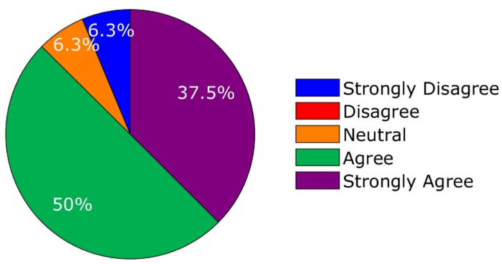


*Figure 9. Distribution of responses regarding the Department Head's decision-making*

Concerning the statement, "The information on the improvement plan generated by the prototype accelerates the feedback that the department head must provide to faculty members," 93.8% of participants expressed they "agreed" or "strongly agreed" (43.8% "strongly agree," 50% "agree"), with only 6.3% "strongly disagreeing." The results are depicted in Figure 10.

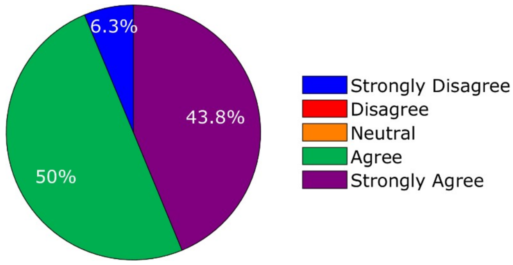


*Figure 10. Distribution of responses regarding the application's impact on accelerating feedback from the department head to faculty*

Finally, regarding the utility of the departmental results and strategic plans for diagnosis and decision-making, 87.5% expressed they "agreed" or "strongly agreed" (62.5% "strongly agree," 25% "agree"), while 12.5% remained neutral. These results are illustrated in Figure 11.

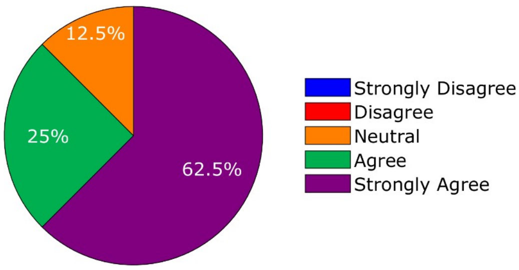


*Figure 11. Distribution of responses regarding the utility of presenting departmental results and strategic plans for diagnosis and decision-making*

These findings confirm that the proposed methodology effectively meets its objective of providing educational managers with a tool that optimizes analyzing faculty evaluations and facilitates evidence-based decision-making.

### 5.4. Effectiveness of Automatically Generated Improvement Plans

A hallmark of the proposed methodology is its automatic generation of personalized improvement plans through artificial intelligence algorithms. The system proved adept at proposing targeted actions aligned with the identified areas for improvement, which were strategically categorized according to the established skill dimensions.

For faculty members with scores below the 3.0 threshold in specific areas such as Effective Communication, Organization, or Teaching Methodology, the application generated tailored improvement plans, Figure 6, comprising:

- A specific diagnosis of strengths and weaknesses is based on integrating quantitative and qualitative data.
- A proposal of 2-3 concrete actions for each identified area of opportunity.
- Recommendations for specific training resources available at the institutional Teaching Center.
- Implementation timelines are typically set for 12 weeks.
- Monitoring indicators to verify the effectiveness of the proposed actions.

The evaluation of these automated improvement plans by department heads was highly positive, as demonstrated by the results presented in the previous section.

At the departmental level, when more than 25% of faculty showed deficiencies in similar areas, Figure 8, the system generated strategic recommendations for collective interventions, thereby optimizing institutional resources for professional development. This capacity for aggregate analysis provides significant added value from a managerial standpoint, facilitating decision-making at the level of entire academic units.

## 6. Conclusions

This research has developed and validated the functional completeness of an innovative application that supports managerial work in the comprehensive evaluation of faculty performance by integrating statistical analysis, text mining, and artificial intelligence. The results demonstrate that this approach provides educational managers with a more precise and efficient diagnostic system, facilitating the systematic identification of faculty strengths and areas for improvement.

The main contributions of this research to the field of educational management are:

- Strategic Categorization of Teaching Skills: The Organization of evaluation items into Soft Skills (Effective Communication, Interpersonal Skills, Time Management, and Organization) and Technical/Professional Skills (Content Mastery and Teaching Methodology) provides a managerially relevant conceptual framework for comprehensive evaluation. This approach made it possible to identify the primary areas for improvement concentrated in the Effective Communication, Organization, and Teaching Methodology subcategories.
- Effective Integration of Quantitative and Qualitative Data: Applying the VADER algorithm for sentiment analysis on student comments and statistical analysis of numerical data generates a more complete and nuanced understanding of teaching performance.
- Automation of Diagnostics and Improvement Plans: The automatic generation of SWOT analyses and personalized action plans reduces the time academic managers dedicate to faculty evaluation to mere minutes, enabling faster, more timely, and specific feedback.
- Proactive Approach to Student Retention: The early identification of attrition risks through the integrated analysis of critical indicators allows for proactive interventions that can potentially enhance the educational experience and institutional metrics. This proactive capability constitutes a significant added value from a strategic educational management perspective.

These findings have significant implications for managerial practice in educational institutions. The proposed solution not only optimizes administrative processes but, more fundamentally, transforms evaluative data into strategic information for decision-making. This aligns with the principles of an effective Management Information System, designed to facilitate organizational communication, analyze strengths and weaknesses, and improve control systems. Specifically, the effectiveness of the intervention was empirically demonstrated following the feedback provided to faculty members based on the system's analysis. A measurable improvement was evidenced, reducing the percentage of faculty members with student evaluation scores below the 3.0/4.0 threshold from an initial 28.1% in the 2425-1 period to 20.6% in 2425-2, and further declining to just 6.5% in the 2425-3 period. This responsiveness to the managerial intervention confirmed the department as a valid ecosystem for testing the proposed methodology.

The methodology presented is highly extrapolatable to other academic institutions that utilize mixed-method evaluations. The fact that the proposed categorization of skills received validation from department heads across diverse disciplines, ranging from Engineering to Social Sciences and Humanities, confirms that the core framework is transversally applicable without the need for structural modification. However, successful transferability requires a context-aware calibration of two operational components. First, the intervention triggers, such as the 3.0 out of 4.0 threshold used in this case, must be adjusted to reflect local grading cultures and strategic goals. Second, and most critically, the sentiment analysis component requires domain-specific localization. While the rule-based nature of VADER ensures computational efficiency, its lexicon must be fine-tuned to capture disciplinary nuances, as the semantic weight of terms may vary significantly between fields. For instance, the term abstract may carry a positive connotation in Mathematics but a negative one in Applied

Engineering. Consequently, this study offers a scalable blueprint for management by exception, allowing academic leaders in diverse contexts to focus specifically on cases requiring support.

The study's limitations include the need to longitudinally validate the impact of the automatically generated improvement plans and continuously adapt the sentiment analysis algorithms to capture the linguistic nuances of specific academic contexts. Future research should explore the comparative effectiveness of different professional development interventions that the system recommends and extend the methodology to other educational levels. Furthermore, the application's functionalities should be extended to offer academic managers views that integrate individual faculty members' historical performance data with their home department's aggregate data. Concurrently, integrating indicators such as grade point averages, withdrawal counts, grade distribution frequencies, and historical course averages will help provide a more comprehensive view of teaching performance, leading to more accurate and efficient decision-making.

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## Declaration of Conflicting Interests

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## Authors' contributions

Sergio Rosales-Anzola: Conceptualization, Methodology, Software, Formal analysis, Data curation, Visualization, Writing - original draft, Writing - review & editing, Project administration. The first author conceived the study, designed the analytical and computational framework, developed the complete MATLAB-based decision support system, implemented the statistical analysis, text mining, VADER sentiment analysis, word cloud visualization, and faculty improvement report modules, curated the dataset, performed the formal analysis of results, prepared the original manuscript draft, and coordinated the study.

Doris Baptista: Conceptualization, Methodology, Validation, Resources, Supervision, Writing - review & editing. The second author contributed the managerial and performance measurement perspective, supported the alignment of the system with organizational performance management principles, contributed to the SWOT analysis of the proposed approach, proposed the incorporation of artificial intelligence to strengthen the decision support framework, proposed the strategic categorization of teaching soft skills for managerial evaluation, facilitated the connection with Teaching Center courses, participated in application testing, and critically reviewed the manuscript.

Christian Guillen-Drija: Conceptualization, Methodology, Validation, Resources, Writing - review & editing. The third author contributed the software engineering and information systems perspective, supported the technical structuring of the system, proposed extending the tool to department-wide evaluation, proposed the strategic categorization of teaching technical and professional skills, participated in application testing and in the validation with Department Heads through system testing, supported the connection with Teaching Center courses, and critically reviewed the manuscript.

All authors contributed to the refinement of the research scope, the interpretation of results, the revision of the manuscript, and the approval of the final version.

## Data availability

Data not available for ethical or legal reasons

## Use of Artificial Intelligence

The authors declare that they have used artificial intelligence for writing, linguistic correction, or style improvement. The authors used Grammarly and Paperpal in order to improve the readability and language quality of the manuscript. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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