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# Standardization of the Academic Process of Laboratories in the Faculty of Engineering in the Industrial Engineering Program, and the Process at the Foreign Language Center of the Universidad Libre de Bogotá

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***Abstract:*** *The Faculty of Engineering at Universidad Libre implemented a system to optimize efficiency, oversight, and regulatory compliance in its procedures. Using tools such as the RACI matrix, risk heat map, process documentation, and time studies, responsibilities, significant risks, and critical points in operational functions were evaluated. The creation of procedures and the accuracy of management indicators transformed everyday tasks into assessable processes open to continuous improvement. As a result, the Faculty is strengthening a comprehensive management system that connects technology and organizational culture, promoting institutional excellence and sustainability over time.*
***Keywords:*** *Improvement, Indicators, Management, Risks, Standardization*

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## I. Introduction

Higher education institutions face the challenge of agility, clarity, and efficiency to meet academic, scientific, and regulatory demands. In this context, the Faculty of Engineering at Universidad Libre initiated a process to support the standardization of its administrative procedures, aiming to improve practices that require support and evolve toward a unified management model. This exercise is not limited to presenting activities or workflows but includes a detailed analysis of governance, risks, and operations, incorporating tools such as the RACI matrix, risk maps, process documentation, and the definition of performance indicators.

Clearly defining roles and responsibilities avoids redundancies and ensures consistency in decision-making, while identifying risks as strategic highlights the needs associated with technology and documentation. Based on these findings, we decided it was essential to establish continuous improvement mechanisms to strengthen safety, security, and regulatory compliance. Furthermore, documenting the validation of activities and creating specifically designed processes, such as chemical control, equipment maintenance, and the academic and administrative management of CLEUL, guides the transition from a reactive to a preventive and planned approach. This progress is accompanied by a time-series analysis that facilitates the identification of bottlenecks in key activities and the need to adopt standardized digital solutions to improve the process.

Finally, the creation of management indicators ensures that documentation and improvement processes are objectively quantifiable, resulting in greater efficiency, stability, and quality in the outcomes. In this way, the Faculty of Engineering strengthens its administration while simultaneously presenting itself as an academic institution committed to institutional excellence and continuous improvement.

## II. Methodology

The first step in establishing roles and responsibilities was the RACI matrix (Table 1), whose objective was to eliminate task redundancy and focus efforts. This system facilitated a hierarchical structure in the decision-making process, beginning with the Faculty Director, followed by the academic coordinators and the human resources manager responsible for support. Both the Flexibility area and the Information Calibration System (KAWAK) were responsible for ensuring the validity and sustainability of the procedures, both regulatory and technological. This aspect is fundamental, since a lack of clarity in responsibilities can be one of the biggest obstacles to the implementation of standardized processes.

Table 1. RACI Matrix

| Task / Stakeholders | Stakeholder 1: Faculty management | Stakeholder 2: Academic Coordinators | Stakeholder 3: Administrative Assistants | Stakeholder 4: Quality Department | Stakeholder 5: Kawak Support |
|---|---|---|---|---|---|
| Task 1: Initial diagnosis of the process | A | R | C | C | I |
| Task 2: Definition of guidelines and scope | A | R | I | C | I |
| Task 3: Documentation of procedures | C | R | R | A | C |
| Task 4: Loading and formalization in KAWAK | I | C | R | A | R |
| Task 5: Staff training in procedures | A | R | I | C | C |
| Task 6: Internal monitoring and audit | A | C | I | R | I |
| Task 7: Continuous Improvement and Feedback Faculty Management | A | R | C | R | I |

However, this characterization of functions needs to be refined (Table 2). Thus, the development of the risk heat map (Figure 1) provides a more strategic view, revealing the lack of documentation of key processes, the restricted use of the KAWAK platform, and the obsolescence of some technical protocols. This series of risks not only affects administrative efficiency but also compromises traceability, security, and regulatory compliance—crucial elements in an academic and scientific context such as that of laboratories and CLEUL. Similarly, risks such as resistance to change, lack of adequate organizational capacity, and absence of regular internal audits indicate that the sustainability of the system depends not only on the organizational culture but also on the technical tools.

Table 2. Risk Analysis

| IDENTIFIED RISK | PROBABILITY | IMPACT | RISK LEVEL | COMMENTS |
|---|---|---|---|---|
| Lack of documentation in key processes | 2 | 4 | 1 | It affects tracea bility and regulatory compliance. |
| Partial use of KAWAK (processes not loaded or pending update) | 2 | 3 | 3 | Risk of lack of document control. |
| Unpublished or outdated technical la boratory protocols | 2 | 5 | 1 | Impact on security, accreditation, and academic management. |
| Need for trai ning of administrative staff in standardization | 2 | 3 | 3 | Limits the sustainability of the quality system. |
| Duplicate or obsolete processes | 2 | 2 | 1 | Creates inefficiencies, but does not affect legal compliance. |
| Absence of systematic inte rnal audits | 2 | 3 | 3 | Affects continuous improvement and preparation for accreditation. |
| Resistance to change in the implementation of new digital tools | 3 | 1 | 1 | Slows progress, but does not compromise immediate compliance. |

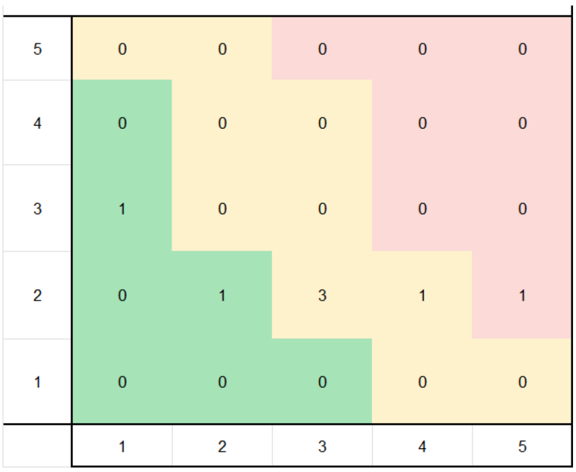


Fig 1. Risk Heat Map

In this regard, the administrative documentation of the validation process for commencing operations became a practical response to the initial challenges. Identifying the main factors allowed for consensus-building and leveraging the institution's experience, as well as the technical meetings organized to validate existing processes and create new ones, such as CLEUL. The analysis revealed that, while some processes remain in place, the lack of periodic review indicates a loss of relevance in the face of institutional and regulatory changes. This underscores the importance of establishing a continuous improvement system.

Therefore, the action plan organized in KAWAK, with its phases of identification, review, dissemination, and follow-up, transforms the application of theory into practice. The problems of the retrospective cycle cannot be resolved unless, in addition, a permanent retrospective is implemented and promoted at the administrative level, ensuring that processes respond more quickly and efficiently to the needs of the Faculty.

## III. Results

During the reactivity control process, an analysis (Table 3) showed that the greatest workload is in reactivity activities, which represent the highest annual total and are the most time-consuming, approximately 243 minutes. These finding highlights management as a critical point in the process. Similarly, it should be noted that transactions such as verifying contaminated items and managing inventories based on statistical principles also require a specific amount of time, limiting operational flexibility. On the other hand, smaller tasks, such as labeling the relevance of substances in the GMS (Environmental Management System) or their placement in the compatibility matrix, although taking no more than 15 minutes, are crucial for safety and regulatory compliance. In this process, the greatest opportunities for improvement lie in the computerization of inventories and the application of barcodes or QR codes, as well as in strengthening waste management processes (Figure 2).

Table 3. Reagent Control Activities

| Inventory control of reagents, chemicals, and consumables | |
|---|---|
| 1 | Verify availability or existence of chemicals, reagents, and/or consumables. |
| 2 | Control inventory based on statistics. |
| 3 | Control the entry and exit of materials using the appropriate forms. |
| 4 | Record consumption |
| 5 | Check the condition of glassware returned by users |
| 6 | Perform a total annual inventory according to the records |
| Receipt and request of supplies | |
| 7 | Request the purchase of reagents and consumables |
| 8 | Request Safety Data Sheets (SDS) for reagents from suppliers, in accordance with SGA and NTC 4435:2010. |
| 9 | Receive reagents and supplies |
| Management of waste and contaminated reagents | |
| 10 | Verify the existence of chemicals, reagents, and/or consumables in the formats |
| 11 | Verify whether there are any contaminated items |
| 12 | Follow waste management procedures |
| Labeling, coding, and storage | |
| 13 | Verify 10 recorded in the total annual inventory in the formats |
| 14 | Verify the reagents and consumables requested |
| 15 | Label chemicals according to the Globally Harmonized System (GHS). |
| 16 | Assign a code to each substance or reagent. |
| 17 | Locate reagents according to the chemical compatibility matrix. |

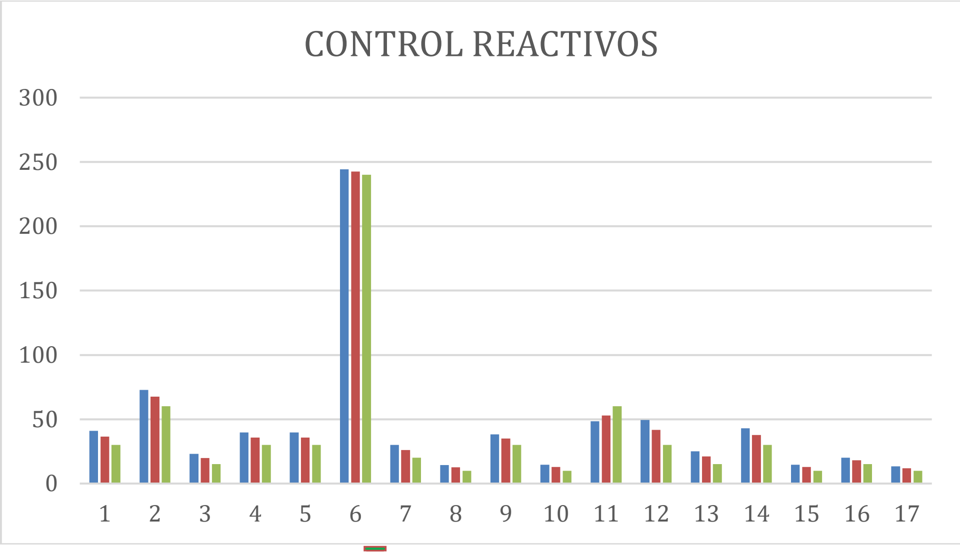


Fig 2. Comparison of Reagent Control Activities

Analysis of the equipment maintenance process (Table 4) showed that, during the scheduling phase, the most time-intensive activity is operator verification and control, averaging seven hours, followed by gathering information on new equipment, at 4.6 hours. In autonomous maintenance, waste management and basic preventive maintenance activities consume 3.4 and 2.6 hours, respectively, highlighting the importance of simplifying these protocols. On the other hand, in external maintenance, the most time is spent verifying purchase orders and reviewing supplier reports, underscoring the urgent need to standardize reporting forms and include efficiency clauses in supplier contracts (Fig. 3).

Table 4. Equipment Maintenance Activities

| Laboratory equipment maintenance schedule | |
|---|---|
| 1 | Verify and control all assets and equipment accordingto inventories. |
| 2 | Collect all information on new equipment. |
| 3 | Create or update the equipment sheet. |
| 4 | Determine semi-annual usage statistics. |
| 5 | Update information in records. |
| 6 | Record the equipment maintenance schedule. |
| Autonomous maintenance | |
| 7 | Perform autonomous preventive maintenance such as operational checks, visual inspections, cleaning, lubrication, or minor repairs. |
| 8 | Quality control of equipment operation. |
| 9 | Fill out the activity log. |
| 10 | Upload it as evidence of maintenance to the "Equipment Maintenance Schedule." |
| 11 | Collect and dispose of waste generated during ma intenance. |
| Maintenance by external provider | |
| 12 | Assess whether autonomous maintenance ensured the proper functioning of the equipment. |
| 13 | If not, validate the providers arranged and approved bythe Department. |
| 14 | Request preventive and/or corrective ma intenance by an external provider. |
| 15 | Verify and ensure that the maintenance provider performs the activity established in the purchase order. |
| 16 | Deliver, receive, and verify the asset along with the provider's final maintenance report. |
| 17 | Deliver the asset maintenance report or file. |
| 18 | Fill in the boxes in the preventive or corrective maintenance log. |
| 19 | If necessary, request the removal of equipment that requires it due to its poor condition. |

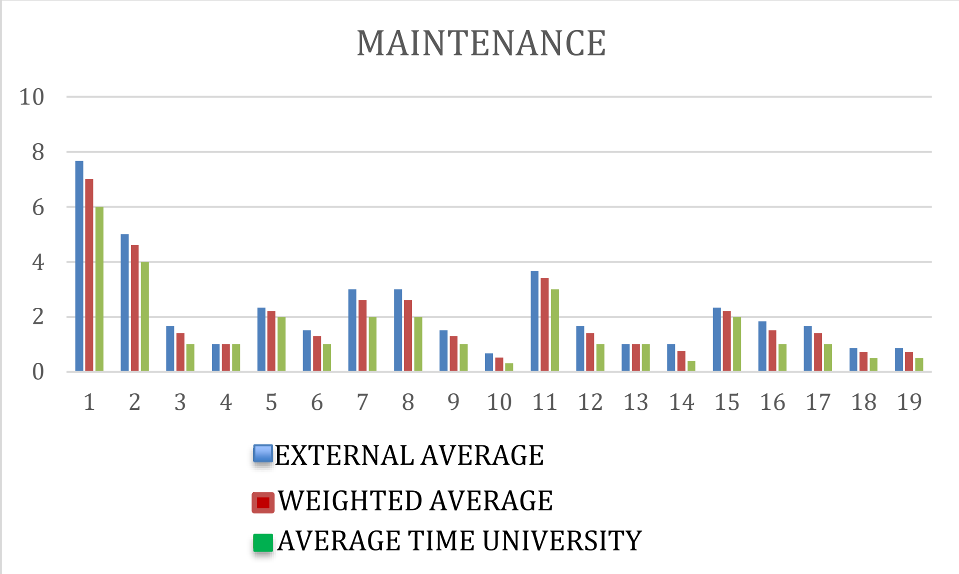


Fig 3. Comparison of Equipment Maintenance Activities

The time spent evaluating student progress is significant, potentially taking up to seven hours, and the time spent preparing certificates requires ten hours, depending on whether the process is internal or external (regarding CLEUL's academic-administrative procedures, Table 5). In pre-registration, call for applications, and interviews, there are notable time differences between the University and external entities, with the latter requiring more time. In the academic context, exam results are obtained more quickly at the University, while the issuance of final diplomas, which must be completed within six hours, demonstrates an excessive administrative burden. Certificate preparation stands out as the most significant task, highlighting the urgent need to incorporate digital solutions that automate this process. Overall, there is an urgent need to implement digital forms, system integrations, and standardization of certificates issued to candidates, which will allow for a reduction in processing time (Fig. 4).

Table 5. CLEUL Activities

| Pre-registration of students in the CLEUL program | |
|---|---|
| 1 | Create and publish the registration schedule. |
| 2 | Register students in the system. |
| 3 | Send an email invitation to students who requested the placeme nt test. |
| 4 | Invite students to a pre-test interview to assess their oral proficiency. |
| 5 | Assess student progress by monitoring their academic performa nce in order to establish their level of proficiency. |
| Academic process | |
| 6 | Register the student at the appropriate level, based on test results or direct enrollment. |
| 7 | Send the placement test results. |
| 8 | Send course information (schedules, content, and materials) to each enrolled student. |
| 9 | Record students' final grades in the academic management system. |
| Certificate creation | |
| 10 | Receiving emails requesting la nguage certificates |
| 11 | Sending the form link to students to complete the language certificate application |
| 12 | Verifying that the information is complete and corresponds to the student requesting the certificate |
| 13 | Preparing the language certificate in accordance with the information provided and in accordance with current regulations |
| 14 | Qua lity control of certificates |

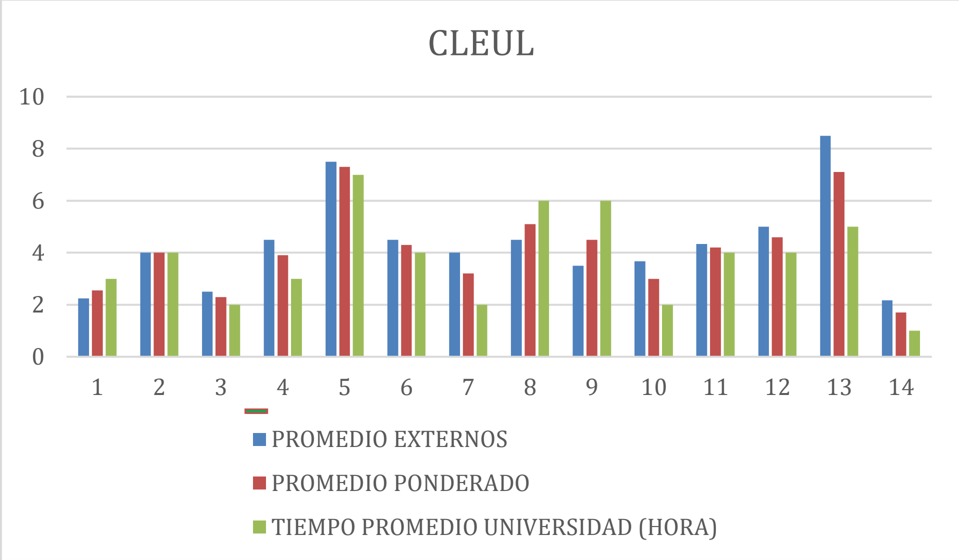


Fig 4. Comparison of CLEUL activities

The time analysis conducted on the administrative processes of the Faculty of Engineering at Universidad Libre identified the activities with the heaviest workloads, highlighting bottlenecks and their impact on service efficiency. These results demonstrate the urgent need for objective measurement tools that quantify, on-site, the time spent, as well as the level of compliance, safety, reliability, and effectiveness of each procedure. In this context, the objective is to establish process management indicators to measure the results obtained, recognizing that indicators are essential components of a quality management system.

With their collaboration, activities that were previously performed routinely can be transformed into measurable, comparable, and optimized processes through continuous improvement, ensuring that management and faculty have verifiable data to support strategic decision-making. The definition of indicators within the Faculty encompasses the three procedures analyzed. In the management and supervision of supplies, reactors, and consumables, the indicators focus on the return of requests, the reliability of stock levels, the recording of consumption, and the efficient use of laboratory resources, guaranteeing transparency, safety, and efficiency. In the maintenance and regulation of laboratory equipment, the indicators analyze compliance with established facilities, the modernization of equipment technical information, and the reliability of suppliers, thereby improving the availability and proper functioning of equipment and supporting the continuity of its academic and research processes.

Finally, CLEUL's management indicators allow for verification of the correct implementation of registration schedules, formalization in the established areas, and the timely issuance of certificates, thus improving the student experience, academic planning, and administrative efficiency. The incorporation of these indicators will transform the management of the Faculty of Engineering into a measurable and controllable system, guaranteeing document transparency, operational efficiency, regulatory compliance, and user satisfaction, as well as serving as a basis for internal and external audits. Furthermore, it will foster a culture of quality and generate an image of the faculty as an academic entity focused on continuous improvement and institutional excellence.

## IV. Discussion

The Faculty of Engineering at Universidad Libre has made progress in standardizing its administrative processes through tools such as the RACI matrix, risk mapping, formalized procedures, and the identification of performance indicators. These mechanisms form the basis of the institution's operations; however, compared to models found in literature, there are opportunities for improvement in the integration system, results orientation, and the digitization of procedures.

According to Bhuyan and Bag [1], combining Lean Management and a Quality Management System (QMS) strengthens organizational efficiency by eliminating unproductive tools that can generate waste and consolidates a culture of continuous improvement. The faculty currently has well-documented procedures; however, it lacks a standard methodology for detecting and eliminating non-value-adding activities. To address this deficiency, the following approach is proposed: implementing the Lean Six Sigma methodology, which Antony, Rodgers, and Cudney [2] describe as a combination of continuous improvement techniques and statistical analysis that maximizes duration, eliminates repetitive processes, and increases the reliability of results in administrative and academic environments.

Regarding process mapping and management, universities are advanced in defining roles and workflows; however, Santos, Azevedo, and Rebelo [3] emphasize the need for higher education institutions to establish periodic review and redesign cycles to ensure the adaptation and relevance of processes in the face of regulatory or strategic changes. This aspect is based on the conclusions of Lin and Lee [4], who indicate that documentation standards are a crucial factor for digitization, suggesting that universities implement more automated platforms (such as KAWAK) that provide greater transparency and document control, replacing the need for manual records.

Another important aspect is the integration of management systems. Pojasek [5] and Sila [6] demonstrate that most organizations operate with isolated systems, which hinders the integration of quality, risk, and performance. In the case of the Faculty, although the functions are defined and their descriptions are clear, there is still no evidence of horizontal integration of the system's elements (quality, environment, safety, and academic-administrative areas). It is recommended to implement an Integrated Management System (IMS), based on the ISO 9001:2015 standard [9], which organizes all processes according to a coherent logic of planning, implementation, verification, and improvement.

Regarding internal control and continuous improvement, Fonseca and Domingues [7] argue that the internal control system should function as an engine of organizational learning, not merely as a monitoring mechanism. Currently, a faculty conducting international audits could strengthen its system through interdisciplinary and intergroup audits, enabling interdisciplinary teams to instantly identify opportunities for improvement. Brown and Duguid [8] complement this idea by emphasizing the importance of having a formal risk assessment methodology integrated into the strategic planning cycle. In this context, they suggested using methods such as Bow-Tie Analysis or the ISO 31000 Risk Assessment Matrix, which facilitate more effective threat prioritization and more efficient preventive response planning.

In the field of risk-oriented thinking, Sousa [11] and Slack, Chambers, and Johnston [10] assert that the operational management of the organization must incorporate the early identification of deviations and the monitoring of indicators of imminent threat. Although the Faculty has defined traceability, compliance, and efficiency indicators, these can be integrated with residual risk and early warning indicators, all in accordance with the approach of ISO 9001:2015. Similarly, leadership training, as suggested by Dahlgaard and Dahlgaard-Park [12], would facilitate the consolidation of a culture of shared responsibility, enabling process leaders to make data-driven choices.

The work of Oakland [13] and Dale [14] emphasizes that operational excellence requires the integration of quality tools and organizational transformation strategies. Within this framework, the University can strengthen its standardization process by incorporating Kaizen (continuous improvement) metacognition (Hammer and Champy [18]) and Knowledge Management metacognition (Argote [25]), which ensure that improvements seen in practice become lasting institutional learning.

Finally, to ensure comprehensive performance measurement, authors such as Kaplan and Norton [27] and Neely [28] suggest systems such as the Balanced Scorecard (BSC), which links indicator results to strategic objectives, user satisfaction, and sustainability. Currently, the Faculty's indicators are used to measure traceability, compliance, and effectiveness, but it is not yet possible to define them in a way that explicitly corresponds to the institute's quality and excellence objectives. Adopting the BSC would allow results to be monitored from four perspectives: financial, internal processes, learning, and users, which strengthens the alignment of the strategy.

In summary, the current mechanisms of the Faculty of Engineering are characterized by a high degree of maturity in documentation, functions, and risk analysis control, and can be improved by incorporating Lean Six Sigma methodologies, SGI ISO 9001:2015, dynamic process mapping, cross-functional audits, risk-based thinking, Kaizen, and the Balanced Scorecard. These tools would facilitate greater digitization, integration, performance evaluation, and continuous improvement, resulting in a more dynamic, proactive, and standards-aligned system of quality and academic excellence.

## V. Conclusions

The standardization of processes in the Faculty of Engineering of the Free University facilitates the creation of an integral management system that encompasses governance, risk analysis, operations and evaluation of results, overcoming the isolated vision of activities. The RACI matrix distributes functions and tasks, optimizing efficiency and organization in decision making. However, the risk assessment highlights the importance of cultural, technological and capacity factors, as well as the need to overcome resistance to change and take advantage of the KAWAK platform. The specifications of procedure documentation, such as those of CLEUL, and the action plan centered on identification, evaluation, dissemination and follow-up guarantee a focus on continued improvement and adaptation to institutional and regulatory changes. The evaluation of implementation plans for reactivity control processes, equipment maintenance and academic management highlights key activities and challenges, emphasizing the urgent need for support for automation, process standardization and automation to optimize resources and streamline tasks. Ultimately, the definition of management indicators provides transparency, ensures regulatory compliance, facilitates internal and external audits and allows the evaluation of efficiency, security and user satisfaction, reinforcing a culture of quality that represents the Faculty as an academic entity of administrative excellence and continued improvement.

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