

Redesigning Industrial Engineering Education: A Strategic Plan for Modernization at UFRGS

Vitória Feijó Macedo, Joyce Danielle de Araújo, Camila Kolling, Paula Kvitko de Moura, Leticia Dexheimer, Joana Siqueira de Souza and Maria Auxiliadora Cannarozzo Tinoco

Department of Industrial Engineering
Federal University of Rio Grande do Sul
Porto Alegre, RS, Brazil

vifeijomacedo@gmail.com, joyce.danielle.araujo@gmail.com, camila_kolling@hotmail.com
paulakmoura@gmail.com, leticiadex@yahoo.com.br, joana.souza@ufrgs.br
maria@producao.ufrgs.br

Abstract

Engineering education is currently navigating a rapidly evolving landscape, with the growing complexity of the job market demanding new knowledge and skills from graduates. This dynamic environment emphasizes educational institutions' need for continuous modernization to ensure their academic programs align with contemporary industry requirements. In this sense, developing a strategic plan and a control system based on performance indicators are fundamental for defining the program's objectives and monitoring their achievement. This study aims to formulate a Strategic Plan (SP) for modernizing the Industrial Engineering undergraduate program at the Federal University of Rio Grande do Sul. The goal is to provide a structured framework to guide the necessary actions for modernization, making the program more attractive to current and prospective students, improving the quality of the training of graduates, and providing an environment of innovation in teaching, research, and extension. Using qualitative research design, benchmarking was carried out concerning undergraduate programs and focus groups for the joint development of the SP and, subsequently, of the indicators in order to engage representatives of the most diverse stakeholder groups (students, professors, graduates, among others) in the discussion. The study resulted in a strategic plan structured in four strategic pillars, which contemplated the main fronts of modernization of the program, which resulted in 21 strategic objectives and, from them, 35 indicators for management and control of the progress of these objectives.

Keywords

Strategic Planning, Undergraduate Education, Industrial Engineering, Performance Indicators.

1. Introduction

The increasingly dynamic and complex job market has consistently redefined and demanded new knowledge and skills from graduates of engineering universities. In addition to technical expertise, they are anticipated to have skills focused on innovation and productivity (Crawley et al. 2007). This scenario prompts educational institutions to modernize in order to align academic training with new trends and expectations of students, employers, faculty, and other stakeholders (Meixell et al. 2015). This update is perceived not only as changes to the curricular structure through the creation of new subjects but also as the inclusion of more contemporary references for delivering materials and content in existing subjects. Although these elements are fundamental and integral to the modernization process, the emphasis is on outcomes; specifically, more than the method to reach the objective, it is feasible to quantify and discern substantial enhancements (Lattuca and Stark 2009).

Acknowledging the imperative of modernization to meet the changing interests of various internal and external stakeholders, including professors, students, graduates, and companies, the Industrial Engineering program at the

Federal University of Rio Grande do Sul (UFRGS) has been seeking innovative solutions since 2019. The Modernization of Undergraduate Education (PMG) project, financed by the Coordination for the Improvement of Higher Education Personnel (CAPES) and the Fulbright Commission, seeks to integrate modifications into the undergraduate curriculum, which encompass curriculum redesign, the development of competency-based assessment formats, and the implementation of innovative learning methodologies (Tinoco et al. 2021; Tinoco et al. 2023). Additional measures implemented encompass the adoption of novel assessment techniques, faculty development, and enhancement of physical infrastructure for classrooms and student-professor interaction areas.

To enhance the analysis of the current context of Industrial Engineering education, it is essential to formalize the progress achieved and identify the desired advancements through a methodology that supports this intricate process. This includes outlining the strategic actions to be implemented, the involved agents, the duration, and the required investment. Strategic Planning (SP) is a viable approach. SP is a systematic process that facilitates the organization and implementation of activities required to meet objectives, while also measuring outcomes and continuously comparing them to future expectations (Maximiano 2023). SP is crucial for Higher Education Institutions as they seek to navigate complex and rapidly changing environments. This process allows them to align academic programs, research initiatives, and administrative practices with internal objectives and external requirements (Armas and Jugo 2024). Furthermore, SP enables the institution to clarify its objectives, the strategies for their attainment, and the methods for assessing the outcomes of these initiatives within the academic context (Lattuca and Stark 2009).

1.1 Objectives

This study seeks to formulate a Strategic Plan for modernizing the Industrial Engineering undergraduate program. The objective is to develop actions and strategies over the next five years to effect changes and enhancements in Engineering education. Therefore, the tool will be crucial in directing the necessary changes to the program structure during this process. Furthermore, performance indicators will be established to assess the implementation of these strategies and evaluate outcomes to determine if these modifications yield the intended result: a more appealing program that equips graduates for the present and future market requirements. This planning is crucial for comparing and establishing relationships between the progress of program modernization projects and the evolution of indicators such as satisfaction, academic performance, competency development, program attractiveness, and the well-being of students and faculty, among other pertinent aspects. The proposed ideas will enhance the specific program and provide a reference for other Engineering programs on both national and international levels.

2. Theoretical Background

A comprehensive conceptualization of SP will be provided, emphasizing its significance in institutional decision-making and detailing its essential stages to guarantee effective implementation and achieving satisfactory outcomes. Subsequently, performance indicators will be examined, highlighting their importance in validating SP and effectively directing organizations toward their objectives and goals.

2.1 SP and Performance indicators

SP is a methodical process that allows organizations to define priorities, distribute resources, and establish goals consistent with their vision and mission. The process encompasses defining the organization's mission, vision, and values, an analysis of the internal and external environment, identifying strategic issues, and formulating strategies and goals (Bryson 2018). This process is designed to achieve a desired future state more efficiently, effectively, and impactfully, while optimizing resource allocation (Oliveira 2003). A participatory approach to SP warrants consideration (Armas and Jugo 2024). Various approaches and models exist for SP development. However, the fundamental stages necessary for successful execution typically encompass: (i) the formulation and clarification of the institution's mission, vision, and values; (ii) the establishment of objectives and goals; (iii) the identification of strategies to attain these goals; and (iv) the creation of action plans for strategy implementation. It also involves the establishment of Key Performance Indicators (KPIs) to assess and manage the attainment of objectives.

The mission denotes the purpose or rationale behind an institution's existence, encompassing its core business, primary value delivery, target audience, and operational segment. Analyzing the external environment is essential for understanding the institution's context, specifically the opportunities and threats present in its operating market. These encompass political, economic, and sociocultural factors that may influence it positively or negatively, while also integrating an analysis of competitors to discern competitive advantages and disadvantages (Maximiano 2023). It is crucial to analyze the internal environment, encompassing its strengths and weaknesses, as well as the organization's

distinctive characteristics (Oliveira 2023). Objectives represent the desired outcomes or conditions that an organization seeks to attain, thereby guiding its efforts, whether qualitative or quantitative. In contrast, goals are defined as specific objectives segmented and accompanied by deadlines (Maximiano 2023).

Performance indicators serve a crucial function in the oversight and assessment of an organization by periodically measuring and comparing expected outcomes with actual results about predefined objectives and goals (Oliveira 2023). The monitoring process is crucial as it indicates the institution's progress within a specified timeframe and assists in evaluating the appropriateness of the planning, highlighting the need for potential adjustments. After comprehending the institution's objectives and delineating them into strategic actions, it is essential to quantify these actions to facilitate progress measurement through indicators (De Camillis et al. 2018).

This approach enables the evaluation of outcomes resulting from implementing planned tasks, projects, and activities. Performance evaluation through indicators in undergraduate programs is an effective management tool, targeting quality and excellence in education (Crepaldi and Diehl 2014) and facilitating the monitoring of various pertinent aspects. Assessing the performance of undergraduate programs involves evaluating how well the needs and expectations of students, the market, regulatory bodies, and society are fulfilled (Crepaldi and Diehl 2014). The modernization of the Industrial Engineering program is driven by the need for engineering education to better align with the contemporary requirements of stakeholders. It is essential to analyze the current context and assess whether the implemented actions are yielding the desired outcomes (Epure 2017). Indicators are essential for assessing the effectiveness of implemented strategies, with the goal of achieving the defined objectives and strategic pillars (Friedrich et al. 2020). This entails creating a system to assess the effectiveness and impact of implemented measures concerning the involved parties, along with collecting their perceptions.

3. Procedures and methods

3.1 Research Classification and Scenario Description

This research is categorized as applied, employing a qualitative and exploratory methodology to address specific issues within an institution. This study is action research involving collaborative development and implementation with professionals from the Industrial Engineering program and relevant stakeholders (Gil 2017). This study utilizes a literature review, prior research from the PMG project, benchmarking against other universities, and focus group discussions to establish familiarity with the topic and ensure alignment with the studied context. This study was conducted in the Industrial Engineering undergraduate program at the Federal University of Rio Grande do Sul (UFRGS). The structure of the Industrial Engineering program at UFRGS features a matrix organization, a model also utilized by other programs at the institution. This structure comprises three primary dimensions. The Undergraduate Committee (COMGRAD) at UFRGS oversees undergraduate education.

Its primary objectives include establishing specific program regulations, defining prerequisites and credit requirements, creating subjects, structuring and organizing the curriculum, and managing student performance, among other responsibilities. The Departments serve as entities tasked with instruction, research, and outreach within a specific knowledge domain. Their duties include faculty training, organizing the curriculum within their discipline, and overseeing the classroom, laboratory, and shared spaces utilized for activities. The Structured Teaching Core (NDE) is a consultative entity comprising faculty members with academic oversight and monitoring responsibilities. It is essential in designing, consolidating, and revising the Program Pedagogical Project (PPP).

3.2 Research steps

The research was organized into two primary phases: Phase 1 - Organizational Identity and Strategic Pillars (3.2.1), and Phase 2 - Strategic Objectives and Performance Indicators (3.2.2). Seven focus groups (FG1 to FG7) were conducted during these stages, incorporating various contributions and participants, as detailed in Table 1.

Table 1. Focus Groups

Group	Focused Group Contribution	Participants	Duration	Formato
FG1	Development of Organizational Identity	PMG Team (1 professor, 3 PhD Students, 1 post-doc student)	01:30	Videoconference
FG2	Validation of Organizational Identity and Development of Strategic Pillars	NDE e PMG	02:00	Videoconference
FG3	Discussion and Identification of Strategic Objectives for Each Axis	2 Students, 4 Alumni, and PMG	02:00	In person
FG4	Discussion and Identification of Strategic Objectives for Each Axis	2 Students, 6 Alumni, and PMG	01:30	Videoconference
FG5	Discussion and Identification of Strategic Objectives for Each Axis	PMG	01:30	Videoconference
FG6	Development of Performance Indicators for Each Strategic Objective	PMG	01:00	In person
FG7	Validation of Strategic Objectives and Their Performance Indicators	NDE and PMG	02:00	Videoconference

3.2.1 Phase 1 – Organizational Identity and Strategic Pillars

Phase 1 comprised two distinct stages. The initial stage focused on establishing the Organizational Identity, encompassing the Mission, Vision, and Values of the Industrial Engineering program at UFRGS. The approach began with the knowledge that defining objectives required a clear understanding of the program's purpose, planned direction, future goals, and fundamental values, assuring alignment with the recommended paths. This phase was initially carried out via benchmarking, considering national and international universities. A study was conducted to identify universities with engineering programs with a structured Strategic Plan disseminated among the academic community. No programs were identified with a Strategic Plan specific to themselves; rather, these plans were formulated at the Engineering School level, thereby including all engineering programs within the institution.

Based on this analysis, five universities were identified as references according to specific criteria: national and/or international significance in engineering education excellence; perceived quality of the content and presentation of published materials; and alignment of values and objectives with the Industrial Engineering program at UFRGS. Furthermore, emphasis was placed on universities that were visited by faculty members and representatives of PMG/UFRGS in the United States, enabling them to provide insights in addition to merely evaluating the strategic plans of these institutions. The preference for U.S. universities stemmed from their leadership in innovative ideas and projects concerning curriculum, infrastructure, and pedagogical practices (Tinoco et al. 2021). At least one national reference was included, recognizing that cultural and regional factors are essential in formulating a Strategic Plan that aligns with the institution's context.

An analysis was conducted on the Strategic Plans of the following universities: Cornell University (New York, USA, 10 years), Georgia Institute of Technology (Georgia, USA, 5 years), University of São Paulo (São Paulo, Brazil, 5 years), University of Illinois at Urbana-Champaign (Illinois, USA, 5 years), and University of Tennessee (Tennessee, USA, 5 years). The documents delineate each plan's location and duration, spanning 5 to 10 years.

A draft was subsequently created, discussed, and validated by FG1. The discussion yielded recorded ideas and insights, resulting in the initial version of the Organizational Identity, which received approval from all meeting participants. Following this definition, FG2 was carried out to present, discuss, and validate the results from FG1, as well as to identify the Strategic Pillars—guidelines that will inform the formulation of Strategic Objectives and subsequently, performance indicators. During this meeting, the NDE offered advisory support and refined the preliminary concepts for the Mission, Vision, and Values, ensuring they align with the program's and institution's guiding principles. Subsequently, the NDE contributed to the definition of the Strategic Pillars, emphasizing the program's modernization via the validation of the Organizational Identity.

3.2.2 Phase 2 – Strategic Objectives and Performance Indicators

The validated Strategic Pillars were decomposed into specific objectives, enabling the planning of associated tasks, activities, and projects. An initial draft was developed by benchmarking against the selected Strategic Plans, facilitating the incorporation of ideas and best practices. Subsequently, two focus groups (FG3 and FG4) were conducted. The

groups included current students and alumni of the program, intending to discuss the Strategic Objectives and plan actions to achieve them, drawing on participants' experiences from various periods.

In FG3, following the Organizational Identity and Strategic Pillars presentation, participants were divided into two groups to discuss, critique, and propose Strategic Objectives for implementing each pillar. Each group received 30 minutes for this activity. Materials, including blank sheets, post-it notes, pens, and highlighters, were provided to facilitate the discussion. Following the 30-minute session, a discussion occurred between the facilitators and both groups, enabling participants to exchange their ideas from the preceding activity. The FG4 session adopted an alternative format: following the Organizational Identity and Strategic Pillars presentation, a discussion was held, allocating approximately 10 minutes to each Strategic Pillar. This open discussion facilitated the contribution of ideas and perspectives by participants. The findings from FG3 and FG4 facilitated the delineation of each Strategic Pillar via the development of Strategic Objectives. FG5 was conducted to structure the intended Strategic Objectives, utilizing the material generated in the previous groups. FG5 established five to six objectives for each pillar.

FG6 advanced the efforts of FG5 by utilizing the previously established materials to devise indicators for measuring each Strategic Objective and to define a minimum of one indicator for each objective. FG7 was conducted to validate the Strategic Objectives and Performance Indicators established in FG5 and FG6. The NDE served both a consultative function in implementing minor adjustments and an active role in refining and constructing the indicators. Their contributions guaranteed that decisions concerning indicator selection, data collection, information presentation, and insight derivation were accurate and substantiated.

4. Results and Discussion

4.1 Organizational Identity and Strategic Pillars

The benchmarking phase with national and international universities generated foundational concepts for organizing the Strategic Plan (SP), enabling the identification of best practices concerning the SP's structure and advancements, including visual identity, document organization, and the dissemination and clarity of the information presented, to enhance comprehension among diverse stakeholders. Through its presentation and organizational strategies, each university exhibited a commitment to adapting to technological advancements and emerging market demands while also fostering creativity, inclusivity, and social impact. Furthermore, shared characteristics among the five examined universities included the ambition to enhance internationalization and the continuous application of active and experiential learning to cultivate "engineers of the future."

Additionally, there was a significant emphasis on advancing research and extension initiatives, enhancing teaching and learning quality, and engagement with the community through various projects. Following the benchmarking with other institutions, FG1 was convened to discuss and formalize the initial version of the Organizational Identity for the Production Engineering program, integrating a vision for modernization: a distinguished, competitive program aligned with market demands and the expectations of new generations of students. Following assessment and consultation with the NDE instructors in FG2, their insights regarding the critical abilities and values in student training were incorporated into the text (Table 2).

Table 2. Organizational Identity of the Industrial Engineering Program at UFRGS

Mission	Vision	Values
Educate professionals proficient in managing and enhancing operations, resolving issues, and creating, and distributing creative solutions with ethical responsibility, within the realm of Industrial Engineering, with the objective of benefiting society at large	Achieve national and international recognition as a leading program in Industrial Engineering and a benchmark for cultivating leaders, managers, and entrepreneurs in many economic sectors	Academic excellence Systemic vision Ethics, diversity, and inclusion Social and Environmental Responsibility Entrepreneurship and innovation Leadership Continuous learning Cooperation and teamwork

Following the formalization of the institution's intentions and desired outcomes, the purposes of the program within the context of modernization became clear. The Strategic Pillars of the program were clearly delineated in FG2. The pillars delineate the areas prioritized by the program to guide its actions toward modernization. The definition of these

pillars enabled their decomposition into Strategic Objectives, ensuring that each priority area encompasses a comparable number of objectives to be attained. Four primary pillars have been established, as illustrated in Table 3.

Table 3. Strategic Pillars of the Industrial Engineering Program at UFRGS

Strategic Pillar	Description
1	Provide a welcoming and inclusive environment
2	Prepare our students to be leaders, promoting innovation and actively contributing to the social, environmental, and economic sustainability of organizations
3	Maintain and enhance excellence in teaching, research, and innovation
4	Expand interactions with alumni, the business community, and society at large

4.2 Strategic Objectives and Performance Indicators

Following the completion of the strategic pillars, which established the institution's objectives, planning necessary goals to attain these objectives commenced. Contributions were solicited from students and alumni representing various graduation years and possessing diverse market experiences to enhance this process. Two focus groups were conducted for this purpose: FG3 and FG4. Both groups engaged in substantive discussions regarding each pillar and its relevance, drawing from their experiences at UFRGS. They provided a comparative analysis of the challenges encountered in the professional market and the impact of academic training, emphasizing the necessary updates to align with current market demands.

The groups proposed pertinent actions and emphasized several critical aspects of the Industrial Engineering program, including the promotion of problem diagnosis and resolution, engagement with the corporate market, and awareness of new tools arising from technological advancements—highlighting the necessity for Industrial Engineers to adopt a proactive stance in learning and utilizing these tools. FG5 was conducted to compile, analyze, and formulate the Strategic Objectives for the application and development of each pillar based on the material produced by the groups. The study was systematically organized to address five objectives for each pillar, ensuring the feasibility of the total number of actions and minimizing discrepancies among the pillars.

Following the delineation of the four strategic pillars, the objectives of the Industrial Engineering program at UFRGS were clarified, establishing a defined trajectory for realizing the institution's goals. Having clearly defined the Strategic Objectives and understood the focal points for program modernization, it became feasible to discuss and plan control indicators to measure the implementation of these actions and the progress associated with each. FG6 aimed to establish performance indicators that effectively assess the achievement of the Strategic Objectives. The objective was to create at least one indicator with a direct correlation to each goal while enabling the indicators also to measure other objectives indirectly simultaneously. Upon completing the deliverables outlined in FG5 and FG6, FG7 was conducted to validate and refine the produced materials, resulting in the final version of the Strategic Pillars, and their corresponding Strategic Objectives and Performance Indicators.

Strategic Pillar 1 seeks to establish a learning environment that prioritizes students' well-being, inclusion, and integration. An environment that incorporates diverse perspectives and is conducive to comfort enhances the learning experience at the University, thereby positively influencing student retention. The strategic actions aim to foster student engagement and a sense of belonging through integration projects, workshops, lectures, and mentorship programs while promoting activities emphasizing inclusion, diversity, and accessibility. A key focus is creating environments promoting interaction and exchanges among faculty, students, and staff. Table 4 outlines the indicators developed for each of the five Strategic Objectives of Pillar 1 and the individuals accountable for planning and monitoring. Assessing student satisfaction with the program is essential for implementation and monitoring.

Table 4. Performance Indicators for Strategic Pillar 1

Pillar		Objective	Responsible	Indicator	Frequency
Provide a welcoming and inclusive environment	E1.1	Monitor student satisfaction with the program and academic environment	DEPROT/ COMGRAD	Average grade in the Institutional Program Evaluation for DEPROT (grade)	Semestral
				Results of Alumni Survey (grade)	Semestral
	E1.2	Promote spaces for socializing and integration for students and professors	COMGRAD	Number of extracurricular activities promoted by the program (n)	Annual
	E1.3	Ensure the curriculum reflects diversity of perspectives and seeks improvement in accessibility	COMGRAD/ DEPROT	Accessibility adequacy index	Annual
				Number of inclusive projects (n)	Annual
				Percentage of women (%)	Semestral
	E1.4	Reduce the dropout rate	COMGRAD	Program dropout rate (%)	Semestral
				Number of active students per semester (n)	Semestral
	E1.5	Encourage student integration with projects from the School of Engineering (extension, research scholarships, student organizations, competition teams, etc.)	COMGRAD	Number of IC students (n); Number of DAProd students (n); Number of EPR students	Annual
				Number of extension projects developed per semester (n)	Annual

DEPROT - Department of Industrial and Transport Engineering; **IC** - Scientific Initiation; **DAProd** - Academic Directory of Production Engineering; **EPR** - Junior Company of Production Engineering of UFRGS.

Strategic Pillar 2 seeks to enable students to assume leadership roles in diverse sectors, thereby fostering beneficial outcomes for organizations and society. The program aims to enhance graduates' capabilities in addressing innovation and sustainability across social, environmental, and economic dimensions, providing them with essential tools for diagnosis and intervention in these fields. The program promotes identifying and resolving problems by engaging in challenges that examine decision-making processes. The program seeks to enhance its internationalization by establishing new partnerships and promoting exchange opportunities, thereby broadening perspectives and facilitating cultural exchange. This pillar aims to promote entrepreneurship, cultivate essential behavioral skills for effective people management, and encourage active engagement and leadership in projects that yield significant social impact, recognizing volunteerism as a crucial avenue for personal growth and societal contribution. Table 5 displays the indicators derived from the Strategic Objectives of Pillar 2 and the designated responsible sections. The indicators concentrate on tracking the quantity of international interactions and the extent of social and entrepreneurial initiatives to evaluate progress toward these objectives.

Table 5. Performance Indicators for Strategic Pillar 2

Pillar		Objective	Responsible	Indicator	Frequency
Equip students with leadership skills, promote innovation, and encourage active contributions to the social, environmental, and economic sustainability of organizations	E2.1	Promote the identification and resolution of problems by creating challenges that investigate the decision-making process	NDE	Number of courses with applied challenges (n)	Semestral
	E2.2	Expand the program's internationalization by establishing new partnerships and promoting opportunities (national and international exchange programs)	DEPROT	Number of students participating in international exchange programs per semester (n)	Annual
				Number of international students enrolled in the program (n)	Annual
	E2.3	Foster an innovative and entrepreneurial mindset among students	NDE	Number of startups/spinoffs created within the program (n)	Annual
	E2.4	Develop behavioral skills including negotiation, inclusive leadership, emotional intelligence, teamwork, and effective communication, among others	COMGRAD/ STUDENT GROUPS	Number of extracurricular activities promoting soft skills (n)	Annual
	E2.5	Create socially conscious programs and activities that give students a chance to participate in real-world community service projects	DEPROT	Number of projects/activities with a social impact (n)	Annual

Strategic Pillar 3 seeks to maintain the continuity of academic excellence in the program's teaching, research, and extension activities. The proposal aims to enhance faculty capabilities through innovative pedagogical practices, including active learning methodologies, competency-based assessments aligned with market demands, and ongoing focus on contemporary teaching strategies. The objective is to engage students in the process by cultivating a feedback culture between students and professors, thereby enhancing educational practices through evidence-based improvements. Enhancing the quality of physical infrastructure and learning spaces, consistently updating curricula and resources, and fostering interaction between undergraduate and graduate programs and extension projects are essential for engaging students and promoting multidisciplinary learning. Table 6 outlines the indicators organized according to the six Strategic Objectives of Pillar 3, including the designated responsible parties. The indicators emphasize the quality of teaching, research, and extension activities.

Table 6. Performance Indicators for Strategic Pillar 3

Pillar		Objective	Responsible	Indicator	Frequency
Maintain and enhance excellence in teaching, research, and extension activities	E3.1	Educate professors on innovative teaching techniques and active pedagogy	DEPROT	Training hours offered per semester (n); Faculty participation in conferences and professional development programs (n)	Semestral
	E3.2	Encourage a feedback-friendly environment between professors and students to enhance instruction over time (evidence-based education)	COMGRAD	Response rate in Institutional Assessment (%)	Semestral
	E3.3	Incorporate competency-based evaluation within the curriculum	NDE	Implementation rate of competency-based assessment in the program (%)	Semestral
	E3.4	Improve the facilities for research, teaching, and extension (classrooms, labs, study spaces, etc.)	DEPROT	Investment in infrastructure improvements (\$)	Annual
				User satisfaction index regarding facilities (%)	Annual
	E3.5	Update the curriculum frequently, making changes to the text, adding bibliographies, and the agile incorporation of emerging topics	NDE	Number of curriculum changes per year (n)	Annual
				Number of publications per DEPROT faculty member (n)	Annual
				ENADE exam result (score)	Triannual
	E3.6	Encourage undergraduate and graduate students to integrate through collaborative projects and activities	DEPROT/PPGEP	Graduate student participation rate in undergraduate courses (%)	Annual
				Graduate student participation rate in extracurricular activities (%)	Annual

PPGEP - Postgraduate Program in Industrial Engineering.

Strategic Pillar 4 seeks to enhance connections among the program, its alumni, organizations, and society, acknowledging these interactions as essential for developing students' skills and competencies, while also fostering their self-awareness and career advancement. This pillar aims to promote the active involvement of industry professionals in courses and supplementary activities, including workshops, lectures, mentoring, technical visits, and other events, thereby facilitating students' ability to link theoretical knowledge with practical application. This interaction facilitates informed decision-making for students regarding their areas of specialization or professional engagement. The text underscores the significance of improving societal interaction and demonstrating academic advancements to enhance the program's appeal to prospective students and the value of the Industrial Engineering profession. Table 7 outlines the indicators associated with the Strategic Objectives of Pillar 4, assessing the degree of interaction with the business sector and society, along with the outcomes of this collaboration on student development.

Table 7. Performance Indicators for Strategic Pillar 4

Pillar		Objective	Responsible	Indicator	Frequency
Expand interactions with alumni, the business sector, and society at large	E4.1	To promote conversations on the real-world implementation of concepts learned, encourage industry professionals to enroll in courses and related events (workshops, lectures, mentoring, technical visits, etc.)	COMGRAD	Number of technical visits per semester (n)	Semestral
				Number of professional development lectures/workshops outside the curriculum (n)	Annual
	E4.2	Increase project development in partnership with businesses	DEPROT	Number of faculty members engaged in projects with companies (n)	Annual
				Number of projects developed in collaboration with companies (n)	Annual
	E4.3	Increase communication with the public by showcasing our efforts and finished products	NDE	Tracking career progress after N years of graduation	Annual
				Alumni employment profile	Annual
	E4.4	Increase communication with the public by showcasing efforts and finished products of Industrial engineering program	DEPROT	Number of media mentions about the program, alumni, or faculty (n)	Annual
				Number of appearances on the School of Engineering's social media (n)	Annual
	E4.5	Make relationships with high schools and boost attendance at career fairs	COMGRAD	Number of school visits/participation in projects, fairs, etc. (n)	Semestral

Establishing the Strategic Plan and its four main Pillars to guide modernization efforts signifies a notable advancement, reflecting a commitment to training Industrial Engineers who are better prepared to address the demands of a dynamic and rapidly changing market and society. Establishing a Strategic Plan (SP) along with a set of indicators to assess the specified objectives offers the institution a definitive framework for reaching its goals (Oliveira, 2023), thereby enhancing its capacity for transformation.

Each pillar reflects an effort to address essential components of student development, including interaction with qualified and current faculty, the promotion of belonging, ongoing learning, and support for personal and professional advancement. The program is dedicated to enhancing student engagement in current initiatives and establishing new opportunities for interaction with the professional market, alumni from various career paths, research, and social impact projects. This proactive approach seeks to provide opportunities for developing social, behavioral, and leadership skills—competencies frequently overlooked by conventional teaching methods in engineering programs (Neto and Amaral 2023; Lerman et al. 2023).

The four strategic pillars incorporate project-based learning and extracurricular activities as essential objectives or performance indicators. Student engagement in projects, whether in partnership with industry or oriented towards social issues, enhances leadership skills, problem-solving abilities, teamwork, and interdisciplinary learning, thereby boosting student motivation (Hadgraft and Kolmos 2020). This engagement and motivation enhanced professional training by facilitating practical learning, contributing to increased program satisfaction and lower dropout rates. Additionally, enhancing collaborations through initiatives across academic, business, and societal domains can increase the program's appeal to both existing students and potential applicants.

The collective analysis of the pillars reveals their interconnection and alignment towards a unified objective: a program focused on continuous improvement, systematically updating its curriculum and teaching practices, thereby enhancing its attractiveness as a career path for new generations and promoting an environment conducive to student retention

and development. The execution of this plan not only demonstrates institutional commitment but also highlights individual and sectoral contributions, as different entities within the program's matrix structure take responsibility for promoting their specific areas. The collaboration among COMGRAD, DEPROT, and NDE is significant, as they will share responsibilities and be involved in implementing and monitoring objectives across all four pillars. COMGRAD will concentrate on curriculum-related issues, academic and extension activities, and program promotion. DEPROT will significantly contribute to faculty development, enhance infrastructure, coordinate projects with companies, and implement initiatives that benefit society. NDE will adopt a strategic role, focusing on alumni career tracking, institutional evaluation metrics, and the management of key indicators, including the percentage of courses utilizing active learning methodologies and the number of curricular revisions conducted.

All indicators have been established with a specified frequency for collection and analysis, with the majority undergoing review either semiannually or annually, except for the ENADE exam (National Student Performance Exam), which operates on a triennial cycle. Consequently, data will be collected and analyzed at six—and twelve-month intervals, facilitating the evaluation of the effectiveness of implemented actions and the determination of subsequent steps. Systematic monitoring will involve data collection and reporting biannually: in September for an interim review of six-month cycle indicators, and in January for the final collection of both semiannual and annual indicators. After each analysis cycle, the NDE will convene a meeting with representatives from student groups and alumni in the industry to assess the data and formulate strategic insights.

The proposed monitoring model ensures the continuity of planned actions and facilitates adjustments in response to emerging market and academic community demands. It also offers a systematic method for revising strategies should the results demonstrate that existing measures are ineffective. The engagement of essential stakeholders—faculty, students, alumni, and industry representatives—along with the active participation of the three primary entities linked to the program (NDE, DEPROT, and COMGRAD), underscores the dedication to modernization and academic excellence. The systematic application of the SP as an institutional framework, coupled with data-informed decision-making grounded in indicator outcomes, reinforce this commitment.

6. Conclusion

The study intended to formulate a Strategic Plan to direct the modernization of the Industrial Engineering program at UFRGS and to establish performance indicators for tracking the anticipated advancements. This objective was accomplished by creating tools that effectively integrate diverse parties. Implementing seven focus groups, comprising faculty members, students, and alumni from various market sectors, facilitated the incorporation of multiple viewpoints and assured coherence with the institution's objectives and principles. Consequently, a comprehensive Strategic Plan was formed to direct modernization initiatives across the four established Strategic Pillars, emphasizing student well-being and engagement, academic performance, and cultivating behavioral and leadership competencies for a new generation of engineers. Evaluating and improving these educational program elements is anticipated to advance the Industrial Engineering program's relevance and appeal, cultivating new competencies and skills while benefiting society at large. The formulation of the Strategic Plan fortified the program's strategic vision, augmented the clarity of its objectives, and delineated the methods for their attainment while facilitating ongoing progress assessment.

To realize these breakthroughs, it is essential to consistently track the indicators and cultivate a culture of dedication to the purpose, vision, values, and defined objectives, ensuring that activities are aligned with these developments. Furthermore, the subsequent steps emphasize the creation of a functional dashboard augmented by an interactive tool. This dashboard must facilitate systematic and real-time data collection and analysis, promoting rapid decision-making while guaranteeing data availability supports the ongoing modernization culture. For future endeavors with information management and systematization, it is imperative to focus on analyzing the outcomes achieved and/or perceived by stakeholders about the measures enacted over forthcoming monitoring cycles. This will facilitate comprehension of progress towards the objectives and enable the assessment of whether their attainment is producing the desired effects. This approach will allow the evaluation of the Strategic Plan's efficacy and facilitate revisions for enhancements.

Acknowledgements

The authors would like to thank CAPES, the Fulbright Commission and the American Embassy for their support within the PMG to carry out the research and the professors and students who participated in the study.

References

- Armas, K.L. and Jugo, R.R., Strategic Development Planning for Global Integration: A Comprehensive Framework for State Universities in the Philippines, *International Review of Management and Marketing*, vol. 14, no. 6, 2024.
- Bryson, J.M., *Strategic Planning for Public and Nonprofit Organizations: A Guide to Strengthening and Sustaining Organizational Achievement*. 5th ed. United States: John Wiley and Sons, 2018.
- Crawley, E. et al. *Rethinking Engineering Education, The CDIO Approach*. New York, NY: Springer Science+Business Media, LLC, 2007.
- Crepaldi, M and Diehl, C. A. Indicadores de desempenho dos cursos de graduação em instituição de ensino superior brasileiro: um estudo de caso sob a percepção dos gestores, *Revista Ibero-americana de Educação*, vol. 65, no. 2, 2014.
- De Camillis, P. K. et al. *Gestão do Desempenho Organizacional*. Porto Alegre: editora Sagah, 2018.
- Demore, C. P., Tinoco, M. A. C., Bertoni, V. B., Marcon, A. and Souza, J. S., Diagnóstico do desenvolvimento de competências do perfil do egresso de engenharia de produção, *Relatos de Experiências em Engenharia de Produção 2021*, ABEPRO, vol. 1, pp. 12-27, 2021.
- Friedrich, M. P. A. et al. Reflexos das Mudanças Estratégicas no Desempenho Organizacional, *Revista Eletrônica de Estratégia and Negócios*, UNISUL-PPGA, 2020.
- Gil, A. C. *Como elaborar projetos de pesquisa*. São Paulo: Atlas, 2017.
- Hadgraft, R. G and Kolmos, A. Emerging Learning Environments In Engineering Education, *Australasian Journal of Engineering Education*, vol. 25, no. 1, 2020.
- Lattuca, L. R. and Stark, J. S. *Shaping the College Curriculum: Academic Plans in Context*. San Francisco, CA: Jossey-Bass, 2009.
- Lerman, L. V., Rodeghiero Neto, I., Souza, J. S., Tinoco, M. A. C., Teaching strategies in industrial engineering programs in Brazil: Benchmarking in North American universities, *ASEE Annual Conference and Exposition*, American Society for Engineering Education, pp. 1-19, Baltimore, USA, June 25-28, 2023.
- Maximiano, A. C. A. *Teoria geral da administração: da revolução urbana à revolução digital* (8^a ed). Rio de Janeiro: Atlas, 2023.
- Meixell, M. J., Buyurgan, N. and Kiassat, C., Curriculum innovation in industrial engineering: Developing a new degree program, *122nd ASEE Annual Conference and Exposition*, American Society for Engineering Education, 26.436. 1-26.436. 10, Seattle WA, USA, June 14-17, 2015.
- Neto, I. R and Amaral, F. G. Teaching occupational health and safety in engineering using active learning: A systematic review, *Safety Science*, vol. 171, 2024.
- Oliveira, D. P. R. *Planejamento estratégico: conceitos, metodologias e práticas* (35a ed.). São Paulo: Atlas, 2023.
- Tinoco, M. A. C., Silva Filho, L. C. P, Caten, C. S. T., Souza, J. S. Danilevicz, A. M. F, Nodari, C. T., Lima, D. R., Dutra, C. C., Paula, I. C. Ribeiro, J. L, D., Redesenho do currículo a partir da análise de stakeholders no curso de graduação em engenharia de produção da UFRGS, *Planejamento e primeiros resultados dos projetos institucionais de modernização da graduação em engenharia (2019/20)*, Programa Brasil-Estados Unidos de Modernização da Graduação em Engenharia (PMG – Capes / Fulbright), ABENGE, vol.1, pp. 121-145, 2021.
- Tinoco, Maria Auxiliadora Cannarozzo; Nodari, Christine Tessele; Rabelo, Luis; Moura, Paula Kvitko de; Marcon, Arthur; Danilevicz, Ângela de Moura Ferreira. Proposition of a method to monitor higher education students' competence development through assessment rubrics. In: 2023 ASEE Annual Conference and Exposition (2023: Baltimore). [Proceedings] [recurso eletrônico], [Washington, DC: ASEE, 2023]. 17 p.

Biographies

Vitória Macedo is an Industrial Engineer, graduated from the Federal University of Rio Grande do Sul (UFRGS). In her thesis, she researched the modernization of engineering education and how Strategic Planning could support this process through a study applied to the Industrial Engineering program at UFRGS.

Joyce Danielle de Araújo is a Ph.D. candidate at the Department of Industrial Engineering of the Federal University of Rio Grande do Sul – Brazil. She is a member of the Organizational Engineering Group (NEO – Núcleo de Engenharia Organizacional) at UFRGS. Her research concerns Smart Supply Chain, Smart Working, and Knowledge Sharing, specifically, how smart working technologies can support supply chain workers.

Camila Kolling is a Ph.D. candidate at the Department of Industrial Engineering of the Federal University of Rio Grande do Sul (UFRGS) – Brazil. She is member of the Innovation and Sustainability Group (NIS – Núcleo de

Inovação e Sustentabilidade) at UFRGS. Her research currently spans the topics of sustainability, sustainable Production and consumption and product development

Paula de Moura is a Postdoctoral Researcher at the Federal University of Rio Grande do Sul (UFRGS) and a Postdoctoral Analyst at the Program for the Modernization of Undergraduate Education. Her research focuses on innovation, sustainability, startups, internationalization of startups, and innovation ecosystems.

Leticia Dexheimer is a Professor in the Transportation and Mobility Engineering Department at the Federal University of Pelotas - Brazil. She is a Postdoctoral Researcher at the Federal University of Rio Grande do Sul (UFRGS). Her primary research interests are logistics, city logistics, sustainable last mile and sustainable urban mobility.

Joana Siqueira de Souza is a Professor in the Industrial Engineering Department at the Federal University of Rio Grande do Sul (UFRGS), Brazil. She holds a Ph.D. (2011) and an M.Sc. (2008) in Engineering from UFRGS. Her research focuses on cost accounting, project evaluation, risk management, and engineering education.

Maria Auxiliadora Cannarozzo Tinoco is a Professor in the Industrial Engineering Department at Federal University of Rio Grande do Sul - Brazil. She earned her Ph.D and M.Sc. degrees in Engineering from the same university in 2011 and 2004, respectively. Her primary research interests encompass engineering education, digital transformation, service management, as well as product and service innovation.