

Academic and Labor Determinants of Engineering Graduates' Satisfaction: A Mixed-Methods Study at a Peruvian Public University

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ABSTRACT:

The objective of this study was to analyze the academic and occupational determinants of satisfaction among engineering graduates from a Peruvian public university. A mixed sequential explanatory design was used to integrate quantitative and qualitative evidence based on their educational and occupational trajectories. In the quantitative phase, 603 graduates participated, responding to a Likert-type questionnaire that measured four dimensions: satisfaction with their degree program, assessment of the curriculum, perceived usefulness of their academic training, and conditions for entering the labor market. With this information, a multiple linear regression model was estimated, considering overall satisfaction as the dependent variable. In the qualitative phase, 125 participants answered open-ended questions about the curriculum, the application of training in real work contexts, and experiences of access to employment; the analysis was performed using thematic coding. The model explained 60.4% of the variance in satisfaction. The perceived usefulness of the training was the strongest positive predictor, followed by the assessment of the curriculum, while job placement conditions had a significant negative effect. The qualitative narratives confirm that graduates value the rigor and technical soundness of their training, but point to gaps in content updating, practical training, use of specialized software, soft skills development, and institutional support for employability. It is concluded that satisfaction depends not only on academic quality, but also on the degree to which the training is perceived as useful and aligned with the real demands of the job and with effective job placement opportunities.

Keywords: Graduate satisfaction; Engineering education; Employability; Curriculum relevance; Mixed methods study.

1) Introduction

In contemporary higher education systems, obtaining a university degree no longer guarantees rapid or successful access to the labor market. In many countries, the massification of higher education has been accompanied by underemployment and informality, generated by mismatches between graduates' skills and job requirements, which affects how graduates evaluate the usefulness of their studies once they enter the labor market. Recent evidence based on data from Peru shows that, although most graduates find some form of paid employment, a considerable proportion remain unemployed or find jobs that do not match their level of qualification, and rates of informality remain high even among those with higher education [1]. In this context, the employment situation of graduates has become a key indicator of the quality and relevance of university education, especially in developing countries where higher education is expected to contribute directly to economic development and social mobility [1].

From an employability perspective, the transition from education to work is understood as the result of the interaction between personal resources, educational experiences, and labor market conditions. Various studies have identified “employability profiles” that combine academic achievements, work experience, field of study, and sociodemographic characteristics, showing that not all graduates benefit equally from the same educational opportunities [2]. Similarly, a recent comprehensive review of the determinants of graduate employability synthesized 74 empirical studies and identified factors such as institutional attributes, educational arrangements, personal and interpersonal factors, socioeconomic conditions, labor market characteristics, and individual physical characteristics. This review highlights that pre-professional internships, work-integrated learning, field of study, academic performance, and social background consistently explain employment outcomes [3].

In this debate, curriculum reforms inspired by Education 4.0 emphasize that employability must

be incorporated into program design and not addressed solely through isolated workshops or elective activities. Studies on curriculum redesign show that aligning learning outcomes with professional roles, incorporating industry-relevant projects, and strengthening the assessment of cross-cutting competencies can make employability a visible and assessable component of the curriculum. However, this same literature recognizes tensions between traditional content-centered models and competency-based approaches, as well as institutional constraints that limit the systematic integration of work-based learning across all programs. These tensions are particularly strong in engineering, where rapid technological change and digitization continually redefine the skills expected of graduates [4].

In engineering education specifically, international studies agree that employers value not only solid disciplinary knowledge, but also communication skills, teamwork, problem solving, and digital competencies. Research conducted with students, academics, and industry representatives has shown notable gaps between the importance employers assign to certain competencies (e.g., project management, oral communication, or teamwork) and students' self-perception of their mastery [5]. Other studies focusing on chemical engineering graduates document a mismatch between university curricula and the complex skill sets demanded by industry, especially in terms of practical experience, systems thinking, and the integration of sustainability and digital tools into professional practice [6]. These studies propose employability skill frameworks for engineering and recommend closer collaboration between universities and employers, but they are mostly based on high-income country contexts and often rely solely on cross-sectional quantitative data.

In parallel, structural equation models with university students show that perceived academic quality, infrastructure, and opportunities to develop employability skills are important predictors of satisfaction, which in turn reinforces institutional reputation, loyalty, and positive word of mouth [7]. Among graduates,

evidence from Chile indicates that satisfaction with the study program depends simultaneously on pre-university background, institutional prestige, current salary, and satisfaction with working conditions, suggesting that graduates' retrospective and assessments are strongly conditioned by their career trajectories [8]. Similarly, a study based on Spanish graduates shows that unemployment, overqualification, and working outside one's field of study significantly increase dissatisfaction with university education several years after graduation [9]. More recently, analyses using data science models applied to a large sample of graduates have identified variables such as income satisfaction, life satisfaction, and the frequency with which the knowledge and technological tools acquired at university are applied at work as key factors in career satisfaction [10]. Taken together, these results underscore that graduate satisfaction is not determined solely in the classroom, but arises from the interaction between academic experience and subsequent employment outcomes.

In the case of Peru, a recent study shows that only about a quarter of graduates enter the formal labor market, approximately half find jobs under conditions considered adequate, and almost a third remain unemployed, with marked inequalities depending on the type of institution, program of study, and socioeconomic background [1]. In this context, engineering graduates are, on average, more likely to find employment than graduates in other fields, but they are not exempt from problems of informality, occupational mismatch, and precarious working conditions. In addition, Peruvian public universities operate under budgetary constraints and regulatory pressures that make it difficult to systematically update curricula, modernize infrastructure, and maintain strong links between universities and employers. This makes it plausible that engineering graduates value certain aspects of their academic training positively and, at the same time, experience frustration with their career paths.

The problematic situation that motivates this study therefore lies in the possible gap between

the academic experience offered by a Peruvian public university and the employment realities faced by its engineering graduates when they enter the labor market. International literature indicates that employability is shaped by a complex set of institutional, educational, and personal factors [2–4], and that labor outcomes—particularly unemployment, mismatch, and low income—can erode graduates' satisfaction with their university education [8–10]. However, there is still limited evidence that jointly examines, in Latin American public universities, how the assessment of the curriculum, the perceived usefulness of training, and certain indicators of employability combine to explain the satisfaction of engineering graduates. In this regard, this research seeks to provide empirical evidence, using a mixed-methods design, on the academic and employment determinants of satisfaction among engineering graduates from a Peruvian public university, generating inputs for curriculum review and policies aimed at strengthening the alignment between university education and the demands of an increasingly digital, competitive, and uncertain labor market.

2) Methods and Methodology

Design

A mixed-methods approach with a sequential explanatory design was adopted for the study, with the aim of analyzing the academic and employment determinants of satisfaction among engineering graduates from a Peruvian public university. This design, described by Creswell and Plano Clark as particularly suitable when seeking to expand and explain quantitative results based on qualitative data, facilitates interpretation and increases the depth of numerical findings [11]. In line with this, the research was organized into two phases: a first quantitative phase, focused on a multiple linear regression analysis to identify the factors associated with satisfaction; and a second qualitative phase, which, through open-ended questions, explored the graduates' perceptions of the training they received and their integration into the labor market.

Participants and sampling

The population consisted of graduates from different engineering specialties at a public university in Peru, comprising the 8,558 graduates who completed their studies between 2019 and 2024. For the quantitative analysis, quota sampling was used, considering the proportions represented by the different engineering degrees, resulting in a sample of 603 graduates.

Instruments

Two questionnaires were used, one for the quantitative phase and one for the qualitative phase. The first instrument was a structured questionnaire with items on a five-point Likert scale (1 = "strongly disagree," 5 = "strongly agree"), consisting of four main sections. The first section assessed satisfaction with university education, measuring the overall degree of satisfaction with the study program and the perceived quality of the education received; the index derived from these items was used as a dependent variable in the regression model. The second section addressed the assessment of the curriculum, gathering perceptions of the internal coherence of the study plan, the balance between theory and practice, and the level of updating of the content. The third section focused on the perceived usefulness of academic training, that is, the extent to which graduates considered the knowledge and skills acquired during their studies to be useful and applicable in their current or recent professional performance. Finally, the fourth section gathered information on experience and labor market insertion.

Procedure

Data collection was carried out through online surveys. In the quantitative phase, the link to the closed-ended questionnaire was distributed by email, accompanied by an invitation explaining the objectives of the study, the voluntary nature of participation, and the procedure for granting informed consent. Once the quantitative data had been analyzed, 125 graduates were selected according to the defined stratification criteria and invited to elaborate on the reasons for the results obtained, thus forming the qualitative phase. This group was sent a second link with the open-ended questionnaire and a brief explanation of the purpose of this stage, emphasizing that their

responses would be used to interpret and contextualize the quantitative findings. Participation in this phase was also voluntary and anonymous.

Analysis of quantitative data

First, descriptive analyses were performed using frequency tables and percentages to characterize the sample and examine the distribution of the main variables. Cronbach's alpha coefficients were calculated to assess the internal reliability of the scales.

Subsequently, a **multiple linear regression model** was estimated with overall satisfaction as the dependent variable. The main predictors were: (a) assessment of the curriculum, (b) perceived usefulness of academic training, and (c) conditions for entering the labor market.

The model was specified as follows:

$$SAT_i = \beta_0 + \beta_1 CURR_i + \beta_2 UTIL_i + \beta_3 INS_i + \epsilon_i$$

Where:

SAT_i : Satisfaction of graduate i

$CURR_i$: Assessment of the curriculum

$UTIL_i$: Perceived usefulness of the training received at the university

INS_i : Conditions for entering the labor market

β_0 : Constant

$\beta_1, \beta_2, \beta_3$: Regression coefficients

ϵ_i : Error term

Compliance with the assumptions of linear regression (linearity, independence of errors, homoscedasticity, normality of residuals, and absence of multicollinearity) was evaluated using scatter plots of residuals against predicted values, normal probability plots (Q-Q plots), the Durbin-Watson statistic, and variance inflation factors (VIF). Model fit was assessed using the coefficient of determination (R^2), the overall F-test, and t-tests for individual coefficients, adopting a significance level of 0.05.

Analysis of qualitative data

The analysis of open-ended responses was conducted considering Saldaña's observations on qualitative coding. At the first level, relevant words, phrases, and segments related to the assessment of the curriculum, the usefulness of the training, and experiences of labor market insertion were identified. Descriptive codes were mainly used to label the central ideas expressed

by the graduates. At a second level, the initial codes were grouped into categories representing recurring patterns of behavior in the discourses. This process made it possible to move from codes close to the text to conceptual categories that facilitate the interpretation of the meaning of the data and the construction of integrated explanations [12]. Among the resulting categories were, for example, perceptions about the relevance and updating of the curriculum, gaps in practical and technological training, mismatches between studies and employment, and assessments of institutional support for job placement.

Integration of results

The integration of results was carried out in accordance with the sequential explanatory design. In the first stage, the coefficients of the multiple linear regression model were interpreted to identify general patterns in the relationship between academic and employment variables and graduate satisfaction. In the second stage, these patterns were contrasted with the categories emerging from the qualitative analysis, seeking convergences, divergences, and complementary explanations. In accordance with the recommendations for mixed studies, this integration phase made it possible to explain the quantitative results based on the experiences reported by the graduates, thereby generating a greater level of understanding and contextualization of how the assessment of the curriculum, the perceived usefulness of the training, and the conditions of labor market insertion are related to satisfaction with university education [11].

3] Results:

3.1. Characterization of the sample

The reference population consisted of graduates from different engineering specialties at a public university in Peru and included 8,558 graduates who completed their studies between 2019 and 2024. From this population, quota sampling was used for the quantitative phase, considering the proportions represented by the different engineering degrees, resulting in a sample of 603 graduates. All had completed their studies at least

one year before the questionnaire was administered, which allowed them to have some work experience when evaluating the training they had received and their integration into the labor market.

3.2. Descriptives of the study variables

Table 1 shows the levels of the variables analyzed in the study. With regard to the curriculum, most graduates rated this aspect as average (45.8%), followed by high (25.2%); low (18.7%) and very low (5.1%) ratings accounted for just under a quarter of participants, while only 5.1% reported a very high rating. Overall, these results indicate a predominantly medium and high rating of the curriculum.

In terms of the perceived usefulness of academic training, the medium (37.5%) and high (38.5%) levels again predominated, together accounting for more than three-quarters of the sample. The low (10.9%) and very low (4.1%) levels were in the minority, and 9.0% expressed a very high rating of usefulness. In general, graduates recognize that their academic training is useful for their professional performance, with ratings concentrated in the medium and high levels.

The situation is different in the case of job placement conditions. Almost two-thirds of graduates were in the very low (25.7%) and low (38.3%) levels, while 29.0% reported a medium level and only a minority were in the high (5.5%) and very high (1.5%) levels. These results indicate that job placement conditions are mostly rated as unfavorable or precarious by a significant proportion of graduates.

Finally, satisfaction with career development showed a more favorable distribution: 37.6% were at the high level and 17.9% at the very high level, while 30.7% reported a medium level. The low (7.8%) and very low (6.0%) levels accounted for a minority of participants. Overall, the majority of graduates report medium or high levels of satisfaction with their professional careers, despite the difficulties noted in their entry into the labor market.

Table 1 Levels of the variables analyzed in the study

Level	Curriculum	Usefulness of academic training	Conditions for entering the labor market	Satisfaction with career development
Very low	5.1	4.1	25.7	6.0
Low	18.7	10.9	38.3	7.8
Moderate	45.8	37.5	29.0	30.7
High	25.2	38.5	5.5	37.6
Very high	5.1	9.0	1.5	17.9
Total	100.0%	100.0	100.0	100.0

3.3. Verification of model assumptions

Before interpreting the regression model, compliance with the assumptions of multiple linear regression was evaluated. Inspection of the histogram and normal probability plot (Q-Q plot) of the residuals indicated a reasonable approximation to normality. The scatter plots of the standardized residuals against the predicted values showed no clear patterns of curvature or heteroscedasticity. The Durbin-Watson statistic was 1.99, suggesting independence of errors. Finally, variance inflation factors (VIF between 1.086 and 1.701) ruled out problems of multicollinearity among the predictors.

3.4. Results of the multiple linear regression model

The multiple linear regression model, estimated on data from 603 graduates, showed a high multiple correlation between the independent variables and satisfaction with career development ($R = 0.777$). The coefficient of determination indicated that 60.4% of the variance in satisfaction was explained by the set of predictors ($R^2 = 0.604$; adjusted $R^2 = 0.602$). The ANOVA test confirmed that the overall model was statistically significant, $F(3, 599) = 304.71$; $p < 0.001$, indicating that the combination of curriculum assessment, perceived usefulness of academic training, and job placement conditions substantially improves the prediction of satisfaction compared to a model without predictors (Table 2).

Table 2 Model summary

Model	R	R squared	Adjusted R-squared	Standard error of the estimate
1	0.777 ^a	0.604	0.602	2.311

a. Predictors: (Constant), job placement conditions, curriculum, usefulness of academic training

b. Dependent variable: Satisfaction with professional career

As shown in Table 3, the three independent variables had statistically significant effects on satisfaction. The perceived usefulness of academic training was the most significant predictor ($\beta = 0.434$; $B = 0.478$; $SE = 0.037$; $t =$

12.96; $p < 0.001$), followed by the assessment of the curriculum ($\beta = 0.369$; $B = 0.421$; $SE = 0.037$; $t = 11.26$; $p < 0.001$). In both cases, higher levels of assessment were associated with higher levels of satisfaction with professional career development. In contrast, job placement conditions had a significant negative effect ($\beta = -0.153$; $B = -0.113$; $SE = 0.020$; $t = -5.71$; $p < 0.001$), such that more unfavorable job situations were associated with lower satisfaction, once the effect of academic variables was controlled for.

Table 3 Regression coefficients

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Dev.	Beta		
(Constant)	4.295	0.629		6.833	0.000
Curriculum followed in your degree program	0.421	0.037	0.369	11,262	0.000
Perceived benefit of academic training	0.478	0.037	0.434	12.955	0.000
job placement conditions	-0.113	0.020	-0.153	-5.714	0.000
a. Dependent variable: satisfaction with their professional career					

3.5 Qualitative results

The qualitative phase analyzed the open-ended responses of 125 graduates from different engineering specialties. Based on appropriate coding, three central elements were analyzed to understand the results of the determining factors of graduate satisfaction that intervene in the regression model: (a) assessment of the curriculum, (b) perceived usefulness of the training, and (c) experiences of labor market insertion. These findings have paved the way for a better understanding of how curriculum assessment and perceived usefulness are positively associated with satisfaction, while job placement conditions have a negative effect.

3.5.1. Perceived strengths and weaknesses of the curriculum

Most graduates reported receiving a demanding technical foundation that strengthened their logical reasoning and critical thinking skills, enabling them to quickly assimilate new tasks and technologies at work. Several faculties also recognize a reasonable balance between theory and practice and recent efforts to update their programs. However, the reports show that this balance is insufficient and uneven across different faculties. Many participants question the updating of content and teaching resources, citing outdated bibliographies, poor integration of specialized software, and laboratories that do not reflect real industry conditions. It is also noted that some faculty members have little connection to the productive sector and rely on methodologies focused almost exclusively on lectures and paper-based problem solving. In this sense, the curriculum is seen as a good

educational foundation, but with a growing gap between current technological and productive demands.

3.5.2. Perceived usefulness of training in professional performance

Most graduates considered that the training they received has been useful for their current performance. Analytical skills, problem solving, critical thinking, and the ability to learn new technologies or processes are particularly valued. Even when the specific content is not applied literally, participants point out that the training allows them to "understand more quickly," "explain problems better," and adapt with greater autonomy than colleagues from other institutions.

At the same time, there is a perceived disconnect between the training and the specific tasks of the job. Many graduates indicate that the use of industrial software, reading norms and standards, project and team management, and the application of work methodologies were mainly learned "on the job" at the company. There is repeated criticism of the excessive emphasis on theory and the lack of opportunities to integrate real projects, simulations, or cases from professional practice.

The recommendations focus on three aspects:

- Digital technologies and skills (specialized software, data analysis, programming, automation tools);
- Soft skills (communication, leadership, teamwork, negotiation, effective presentations); and

- Professional contextualization (knowledge of fields of practice, typical roles, specialization paths, and certifications).

Qualitative evidence supports the results of the regression model, in which the perceived usefulness of training is shown to be the strongest determinant of satisfaction: when graduates feel that they can apply what they have learned and that the university has prepared them to face real problems, satisfaction remains high even in difficult work contexts.

3.5.3. Work placement experiences

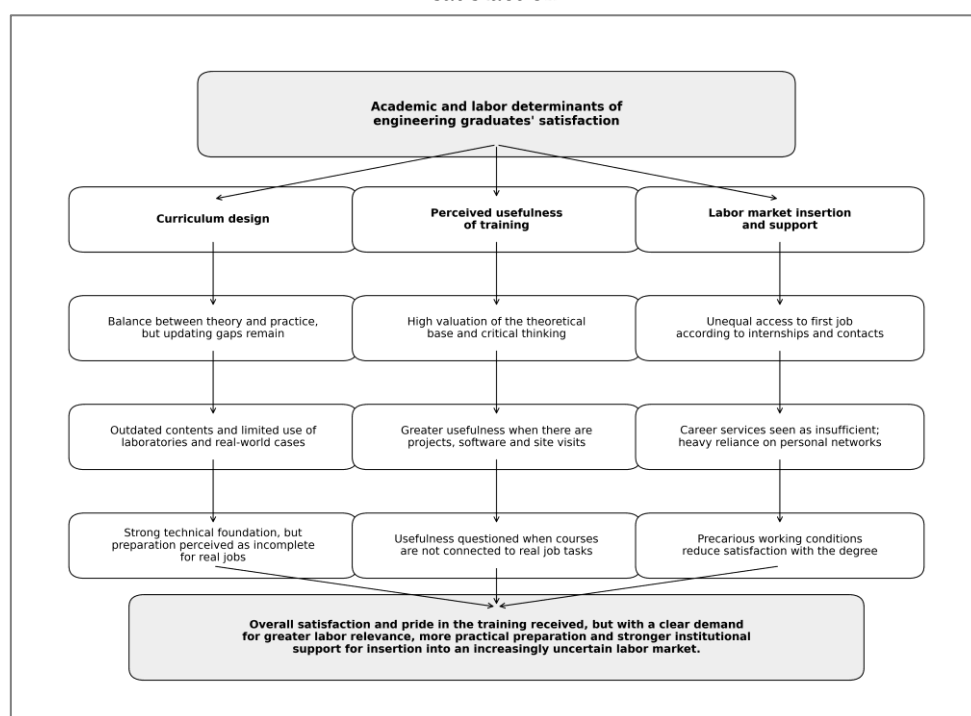
Job placement experiences are mixed. A significant group of graduates obtained their first job within a few months, especially those who had pre-professional internships or work experience during their studies; in these cases, the prestige of the university is perceived as an advantage in the selection process. However, others report that it took them a long time to find work, that they accepted positions below their level of training or in areas unrelated to their career, generally with low salaries and unstable contracts. In almost all accounts, the importance of personal networks (colleagues, friends, graduates from the same university) as the main

route to employment is recognized. Job boards and job fairs are valued, but are considered insufficient in terms of coverage and continuity, especially for certain specialties. Among the priority actions, graduates proposed expanding and diversifying agreements with companies, strengthening employability services (resumes, interviews, soft skills), developing alumni networks and mentoring programs, and offering greater vocational guidance and support in the transition to the job market.

These testimonies help to understand why the factor of labor market entry conditions appears to have a negative effect in the quantitative model: when the transition from university to work is slow, unstable, or precarious, graduates begin to question the usefulness of what they studied and how relevant the curriculum was, and this reduces their overall satisfaction with their degree program.

Figure 1 graphically summarizes the links between the themes that emerged in the qualitative phase and the academic and employment determinants of graduate satisfaction.

Figure 1 Semantic network of academic and work-related determinants of engineering graduate satisfaction



3.5.4. Interpretive synthesis

Taken together, the testimonies paint a "two-sided" picture of the education received. On the one hand, many graduates say they are proud of the academic rigor and technical foundation provided by the university. On the other hand, they point to problems with curriculum updates, lack of real-world practice, and insufficient institutional support for finding employment.

The qualitative results helped to better understand what the multiple linear regression model showed:

- When graduates rate the curriculum highly and, above all, feel that what they have learned is useful in their work, they tend to be more satisfied with their career. In these cases, university education becomes a foundation that allows them to learn, adapt, and continue to grow professionally.
- On the other hand, when their experiences of entering the labor market include unemployment, jobs below their level of education, or precarious conditions, graduates begin to question what their degree was really good for, and this reduces their satisfaction with their studies.

In summary, the qualitative results show that increasing graduate satisfaction requires more than just academically demanding training. It is also necessary for what is taught to be better connected to the world of work, for there to be a stronger relationship between the university, companies, and graduates, and for training to focus not only on technical knowledge, but also on digital, h , and socio-emotional skills. All of this would help engineers to be better prepared to face an increasingly changing and uncertain job market.

3.5.5. Meta-inferences from the study:

integration of quantitative and qualitative results

The quantitative and qualitative results agree that the satisfaction of engineering graduates depends both on their experience at university and on how they fare later in their careers. The regression model showed that graduates are most satisfied when they feel that the training they received is useful in their work, and secondly when they value the curriculum highly. On the other hand,

when their job placement conditions are difficult (unemployment, underemployment, precarious jobs), their level of satisfaction clearly drops. The qualitative part helps to better understand these results and see what lies behind these relationships.

Transformation

The quantitative analysis showed that the factor that most influences satisfaction is that graduates feel that the training they received is useful. This is better understood when reviewing the responses to the open-ended survey: many highlight that the university gave them a good foundation in critical thinking, logical reasoning, and problem solving, but they clarify that what really maintains their satisfaction is being able to apply that knowledge in real work situations.

Something similar occurs with the curriculum. Graduates tend to view it as a positive aspect because they recognize that it offers a solid structure and a level of rigor that allows them to differentiate themselves in the job market. However, qualitative information provides a better understanding of the mechanisms underlying these associations. Along with this assessment, there are criticisms of outdated content, limited use of technological tools, and teaching that is too focused on theory. In other words, the curriculum is considered a good foundation, but insufficient to fully meet the current demands of engineering work.

In terms of job placement conditions, the negative outcome of the model is better understood when reading the testimonials. Those who have experienced prolonged unemployment, underemployment, low wages, or precarious contracts tend to question both their training and the relevance of the curriculum more strongly. The absence or scarcity of pre-professional internships, the requirement of prior experience for entry-level positions, and the heavy reliance on personal contacts reinforce the feeling that the university provides a good academic foundation but little support for accessing quality jobs.

Expansion

The triangulation of results shows that satisfaction with education and perceived job

relevance are not incidental variables, but rather aspects that broaden our understanding of how graduates evaluate their academic and professional trajectories overall. Although most say they are satisfied with their degree and proud to have studied at a demanding university, this satisfaction diminishes when they assess the correspondence between what they have learned and the demands of the labor market.

The open-ended responses consistently point to the need to strengthen: (a) the practical component of training (up-to-date laboratories, applied projects, simulations, use of norms and standards); (b) the systematic incorporation of digital tools and specialized software; and (c) the development of soft skills and employability competencies (communication, leadership, teamwork, CV preparation, interviews). These elements do not appear as separate variables, but as conditions that broaden or restrict the impact of the technical foundation on satisfaction and job placement.

Convergence

The integration of the results allows us to draw three main conclusions:

First, both quantitative and qualitative data agree that universities offer a solid technical foundation, but that training is not fully aligned with the technological and social demands of today's labor market. Second, graduates are more satisfied when they feel they can apply what they have learned in real work situations and when the university gives them clear opportunities for contact with industry (internships, projects, agreements). In these cases, the perceived usefulness of the training and the assessment of the curriculum translate into high levels of satisfaction, as observed in the regression model. Third, experiences of late or precarious job placement weaken this satisfaction and help to understand the negative effect of job placement conditions in the model: when finding employment depends almost solely on informal contacts, or when the positions obtained are unrelated to the engineering profile, graduates tend to question whether their training was really relevant.

Overall, the meta-inferences indicate that the satisfaction of engineering graduates is maximized when a balance is achieved between a solid academic foundation, relevant practical training, and effective institutional support for employability. This implies moving toward more up-to-date curricula that are connected to industry, strengthening the development of digital and socio-emotional skills, and consolidating systematic job placement policies that reduce the gap between educational experience and the realities of an increasingly competitive and uncertain job market.

4] Discussion

The objective of this study was to analyze, using a sequential explanatory mixed design, the academic and employment determinants of satisfaction among engineering graduates from a Peruvian public university. The results show that satisfaction with professional career development is, on average, high, but coexists with mostly unfavorable job placement conditions. The multiple linear regression model indicates that satisfaction is explained mainly by the perceived usefulness of the training and, secondarily, by the assessment of the curriculum, while labor market conditions have a significant negative effect. Qualitative findings complement these results and reveal a tension between a solid academic foundation and a preparation that is perceived as only partially aligned with current labor market demands.

The high proportion of graduates with medium and high levels of satisfaction is consistent with studies that associate perceived academic quality, infrastructure, and opportunities for skills development with higher levels of student satisfaction and institutional reputation [7]. As in research conducted in Chile and Spain, satisfaction is not determined solely by academic experience, but also by subsequent career trajectories [8,9]. In our case, graduates value the education they received and the prestige of the institution, but this assessment is eroded when job placement is slow, precarious, or occurs in lower-skilled positions, as Espinoza et al. also point out for Latin American and European contexts [8–10].

The finding that labor market conditions are negatively related to satisfaction confirms that, in contexts of underemployment and informality such as Peru, employment outcomes are a central component in the retrospective evaluation of higher education [1]. Qualitative evidence shows that prolonged unemployment, temporary contracts, low wages, and the need to rely almost exclusively on personal networks to access opportunities reinforce the perception of a mismatch between the promise of training and actual employment opportunities, in line with what Iriondo et al. report for mass higher education systems [9,10].

One of the central contributions of the study is to have shown, with integrated quantitative and qualitative evidence, that the perceived usefulness of training is the most influential factor in graduate satisfaction. This result coincides with reviews that indicate that employability is enhanced when programs incorporate authentic learning experiences, pre-professional internships, and industry-related projects [3,4]. The graduates who report the highest satisfaction are those who perceive that the knowledge and skills they have acquired enable them to tackle real problems, learn new technologies quickly, and stand out in selection processes.

The assessment of the curriculum is also positively associated with satisfaction, reflecting that the curriculum offers a demanding and coherent educational structure. However, qualitative testimonies show that this assessment coexists with criticism of the updating of content and resources. In line with studies in engineering, particularly chemical engineering [5,6], the graduates in this study point to gaps in the use of specialized software, the availability of laboratories that simulate real environments, and the incorporation of contemporary frameworks and methodologies (e.g., BIM, data analysis, or automation tools).

This convergence indicates that curriculum reforms inspired by Education 4.0 have not yet fully translated into work-integrated learning experiences at Peruvian public universities. The curriculum is perceived as a good technical

foundation, but incomplete in responding to an increasingly digitalized and project-oriented, h y market, which reproduces the tensions described in the literature between traditional content-centered models and competency-based approaches [4].

Qualitative information consistently showed the need to strengthen three groups of competencies: technological and digital tools, soft skills, and professional contextualization. Graduates report having learned much of the industrial software, technical norms and standards, and project management methodologies directly in companies, rather than during their studies. They also believe that communication, leadership, teamwork, and emotional management are developed more in student groups or on their own initiative than through the formal curriculum.

These gaps are consistent with studies that document discrepancies between the skills that employers consider critical (communication, project management, collaborative work) and students' self-perception of their mastery of these skills [5]. To the extent that these skills are key to employability, their marginal treatment helps explain the perceived disconnect between training and the demands of actual work.

On the other hand, the results show that institutional support for labor market insertion is considered insufficient in terms of coverage and continuity. Although the university offers a job bank and job fairs, many graduates point out that access to quality jobs depends above all on personal networks and informal contacts. This situation contrasts with recommendations in the literature that emphasize the importance of structured employability services, graduate networks, and systematic university-business links to facilitate the transition to work [2,3].

Based on the findings, several implications can be considered for public universities that train engineers in similar contexts:

- Continuous curriculum review and updating, explicitly incorporating learning outcomes linked to digital skills, project management, and collaborative work, as well as

project-based and work-based learning spaces (internships, work placements, projects with companies), as suggested by Education 4.0 frameworks [4].

- Strengthening the practical and applied component of specialized courses through modern laboratories, simulators, case studies, and the systematic use of technical norms and standards. This does not imply abandoning the theoretical basis, but rather articulating it with real problems in the productive environment.
- Curricular integration of soft and employability skills, avoiding their exclusive dependence on extracurricular initiatives. Workshops on communication, leadership, negotiation, teamwork, and preparation for selection processes could be linked to project courses, theses, or pre-professional internships.
- Development of more robust institutional job placement services, including mentoring programs with graduates, psychological and vocational support in the transition to employment, and specific strategies for the reintegration of those who change fields or have interrupted their career paths.
- Systematic monitoring of graduates, both in terms of job outcomes and perceived satisfaction and relevance, in order to provide feedback for academic management and strategic planning, in line with international experiences that use graduate surveys to guide continuous improvement [8–10].

Among the strengths of the study are the use of a mixed sequential explanatory design, which allowed for combining the explanatory power of multiple linear regression with the interpretive depth of qualitative narratives, and the sample size, which includes graduates from various engineering specialties from a recent graduating cohort.

However, there are limitations that must be considered. First, the data come from a single public university, which limits the generalizability to other institutions and contexts. Second, the cross-sectional design prevents the establishment of strict causal relationships between education, employment outcomes, and satisfaction. Third,

the labor market insertion variables are based on the perceptions of graduates and do not incorporate external indicators (e.g., administrative records of employment and income).

Future research could extend the analysis to other public and private universities, incorporate longitudinal measures that follow graduates over time, and include objective labor market indicators. It would also be relevant to deepen the analysis of subgroups (by specialty, gender, or socioeconomic background) to identify specific inequalities in employment trajectories and satisfaction with education.

The results confirm that, in the context of a Peruvian public university, the satisfaction of engineering graduates is built at the intersection between a demanding but incompletely updated academic education and a labor market characterized by precariousness and growing competition. The university offers a robust technical foundation that graduates value and that is reflected in relatively high levels of satisfaction; however, gaps in practical training, cross-cutting skills, and support for labor market integration limit the potential of that foundation to translate into stable, quality career paths.

Addressing these gaps requires going beyond specific curricular adjustments and involves rethinking the relationship between universities, students, graduates, and the productive sector. Only then will it be possible to strengthen the relevance of engineering education and contribute more decisively to the employability and well-being of graduates in an increasingly digital, competitive, and uncertain job market.

5] Conclusion

The results show that, in general, engineering graduates are satisfied with their careers, but not all to the same extent. Most express moderate or high satisfaction, although many have had difficulty finding employment or have worked in jobs with poor conditions. This indicates that they value their education but feel a gap between what they expected upon graduation and the reality of the labor market.

The factor that most influences satisfaction is the perceived usefulness of the training. When graduates feel that what they have learned is useful in their work and can be applied in real situations, their satisfaction remains high, even if the work context is complex. How they rate the curriculum also has a positive influence, while job placement conditions (unemployment, underemployment, low wages) significantly reduce their satisfaction.

The curriculum is perceived as a good technical foundation: graduates recognize that the training is demanding and provides them with solid scientific knowledge. However, many consider it incomplete: there is a lack of content updates, use of current software, more relevant laboratories, and integration of real-world projects and cases linked to the industry.

Job placement conditions become a risk factor for satisfaction when graduates face unemployment, jobs below their level, low salaries, or positions unrelated to their specialty, and when they depend almost solely on personal contacts to access opportunities. In such cases, graduates critically review the usefulness and relevance of their studies.

Graduates point to clear gaps in cross-cutting skills and institutional support for employability.

They ask for more training in digital tools and updated software, in soft skills (communication, leadership, teamwork), and in guidance on fields of work, roles, specializations, and certifications.

Finally, the results indicate that improving graduate satisfaction requires a comprehensive strategy: a good academic foundation is not enough. It is necessary to update curricula, strengthen practical and technological training, improve the university-business-graduate relationship, and offer solid employability services to bring university education closer to the real demands of the labor market.

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8] Data Availability:

The data supporting the findings of this study are available in SPSS .sav and Excel .xlsx file formats.

9] Conflict of interest:

The authors declare that there is no conflict of interest.

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